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MYCOLOGY. —*Three new species of* Conidiobolus *isolated from leaf mold.* CHARLES DRECHSLER, U. S. Department of Agriculture, Plant Industry Station, Beltsville, Md.

Recently I reported (Drechsler, 1952) that *Delacroixia coronata* (Cost.) Sacc. & Syd., a saprophytic entomophthoraceous fungus which earlier was encountered only rarely by mycologists and was generally presumed to be very meagerly distributed, is in fact virtually ubiquitous on leaf mold and other vegetable materials undergoing slow decay in moist contact with the ground. Separate cultures of the fungus, free of alien organisms, are with little effort obtainable in large numbers from isolation plate cultures prepared by fastening portions of decaying plant detritus with soft agar in a central area on the ceiling of each Petri dish. The soft agar employed not only serves as an adhesive matrix securely holding all particles of detritus in a canopylike layer about 10 mm above the layer of sterile agar on the floor of the Petri dish, but also supplies moisture to all detritus particles and thereby encourages prompt germination of any conidia or resting spores that may be present. Since in *D. coronata* either repetitional or mycelial development soon leads to formation and violent discharge of new conidia, macroscopically discernible mycelia of this fungus are commonly found growing in a maizemeal-agar plate within 48 hours after the canopy of leaf mold has been superposed. From the regularity with which *D. coronata* develops in canopied agar plates, even though only 0.2 to 0.3 gram of leaf mold is used in each Petri dish, it would seem beyond question that this fungus must exist in our middle and northern latitudes more abundantly than any of the numerous conspicuously insectivorous species through which the Entomophthoraceae have long been familiar.

The frequently early appearance of *Delacroixia coronata* in canopied plate cultures, together with its rapid growth, its prompt production of numerous conidia, and the forceful projection of these conidia over adjacent areas, makes more difficult the detection and isolation of less vigorous entomophthoraceous fungi likewise commonly present in leaf mold and other slowly decaying residues. Mainly for this reason few cultures referable to *Conidiobolus* were obtained from several dozen of the first canopied agar plates I prepared with leaf mold from different localities in Maryland and Virginia. The difficulties consequent to excessively close seeding of the conidia on the sterile substratum were later obviated with fair success by leaving agar plates exposed to conidial discharge for only a few hours, especially during the third and fourth days after the canopy had been prepared. Conveniently sparse seeding was obtained by removing the lid and its adhering canopy at successive intervals to a new bottom containing a newly poured plate of sterile maizemeal agar, each agar plate after exposure being immediately covered with a sterile lid. After 6, 8, or 10 hours, when some of the scattered conidia had grown out vegetatively, the resulting mycelia could be detected readily by examining the agar surface with the naked eye by reflected light. Through early removal of the young mycelia to sterile maizemeal agar slants plenteous collections of pure cultures were obtained; in these were included, besides *D. coronata* and some almost equally vigorous entomophthoraceous species, a number of related species less obtrusive because of their

slower growth and feebler conidial propulsion.

Most of the entomophthoraceous fungi thus isolated seem best assignable to the genus *Conidiobolus* erected by Brefeld (1884) primarily on his *C. utriculosus*, a robust species that made its appearance adventitiously in nutrient solution he had placed under fruiting bodies of *Hirneola* and *Exidia* for the purpose of germinating discharged basidiospores. From the scale of magnification indicated for the relevant figures, the disjunctive mycelial hyphae of this species seem to vary from 10 to 20μ in width. Its globose zygospores are stated to measure 60 to 100μ in diameter. Its conidia are described as being pear-shaped, with a length of 50μ and a width of 35μ. Although such large dimensions should help to invite notice, *C. utriculosus* has apparently not been recorded again at first hand since its description 68 years ago. Brefeld also reported as occurring on some "Tremellinen" a second species of *Conidiobolus* with conidia he stated to be scarcely one-third as large as those of *C. utriculosus*. The few illustrations he gave of these smaller spores show lengths varying from 20 to 23μ and widths varying from 14 to 15μ. Since in his material the smaller species always became overgrown at an early stage by the more vigorous *C. utriculosus* he was unable to cultivate it separately, and only rather provisionally named it *C. minor*. No additional first-hand report of this tentative species is known. In view of the circumstances under which it was observed its distinctness from *C. utriculosus* is open to serious doubt, for in all fairly robust species continued repetitional development leads to marked reduction in conidial size and indeed often brings about dimensional differences more pronounced than the differences noted by Brefeld. On the other hand, if the assemblage of entomophthoraceous fungi I have so far isolated from decaying plant detritus is at all representative, species with relatively small primary conidia are more numerous than species rivaling *C. utriculosus* in the size of their asexual spores.

Nevertheless, a saprophytic member of the Entomophthoraceae that appears even more robust than *Conidiobolus utriculosus* was obtained by Gilbert (1919) from fern prothallia grown in water cultures or on moist sphagnum. The large globose primary conidia of this fungus, which are described as measuring 48 to 60μ in diameter, would seem alien both to *C. utriculosus* and to *Delacroixia coronata*. The propulsion of these conidia often for a distance of 65 mm bespeaks a discharge mechanism several times more powerful than any mechanism operative in the different species of my collection. As Gilbert's account makes no mention of hirsute resting spores or of any production of small conidia on multiple short outgrowths extended from large conidia, the fungus may eventually find a place in Brefeld's genus. Apparently it has not been reported again during the 33 years since it was first made known and has not hitherto appeared among my cultures.

More recently Couch (1939) fully described under the binomial *Conidiobolus brefeldianus* a readily culturable entomophthoraceous fungus he obtained as a contaminant in an agar plate that had been exposed to spore discharge from a fruiting layer of *Septobasidium apiculatum* Couch on *Cornus amomum* Mill. From *Conidiobolus utriculosus*, with which it makes up the meager established membership of the genus, this fungus differs by its generally smaller dimensions—the width of its hyphae being given as varying from 5.4 to 8μ, the thickness of its spherical conidia as varying from 10 to 31μ, and the diameter of its zygospores as varying from 18 to 33μ. Canopied agar plate cultures prepared with plant detritus taken from localities near the District of Columbia during the winter of 1951–52 have not yielded *C. brefeldianus*, but the species has come forth abundantly in cultures prepared with small quantities of some dry plant detritus which W. F. Jeffers kindly collected early in July 1951 in woods near Tampa, Fla., and near Statesboro, Ga.

While canopied agar plate cultures are very serviceable in bringing to light a category of entomophthoraceous fungi that are not often encountered by chance, and in showing such fungi to be virtually ubiquitous on slowly decaying detritus, they are far

less helpful than might be desired in disclosing what particular constituents of detritus samples were used as sources of nourishment. Owing to the forceful discharge of conidia by the fungi in question, and to successive repetitional development of the discharged spores, it may be presumed that during prolonged periods of rainy weather numerous constituent particles near each particle used as a nutrient substratum will become bestrewn with conidia in greater or lesser abundance. Naturally when samples of detritus are gathered before drier conditions have supervened, and portions of them are fastened soon afterwards in a moist matrix to the ceiling of a Petri plate, some of the conidia adhering to merely contaminated particles may be expected to produce and shoot off new conidia that will be no less effective in establishing mycelia on the agar below than conidia shot off from the nutrient particles themselves. It is true that if canopied cultures are prepared with detritus that has previously been exposed for several months to gradual drying, all the earliest new conidia may be expected to have their origin from the germination of resting spores, which, except in *Delacroixia coronata*, are commonly formed on the assimilative hyphae, and therefore should be present mainly in nutrient particles. Such germination, however, entails some delay, so that when the earliest new conidia fall on the agar floor the whole canopy has become so badly overgrown with alien molds that the individual particles are obscured beyond recognition.

Although the species of Entomophthoraceae readily growing in pure culture on ordinary substrata are often termed "saprophytic" they do not, as a rule, thrive well in the presence of putrefactive organisms. Even rather slight bacterial contamination often halts their vegetative development completely, and subsequently brings about degeneration of their mycelial hyphae and asexual reproductive apparatus throughout the affected area. In agar plate cultures exposed to promiscuous contamination they are often rather strongly repressed by filamentous fungi little noted for antagonistic behavior. Against generally antagonistic molds, as, for example, species of *Penicillium*, *Aspergillus*, and *Trichoderma*, they show, on the whole, very little endurance. Rather commonly when their conidia fall near such molds neither vegetative nor repetitional germination ensues, but the spores turn dark and degenerate internally.

Despite the wide assortment of filamentous fungi with which they were often intermixed in older plate cultures, none of the species in my collection have been seen attacking other molds. In view of Brefeld's statement that *Conidiobolus utriculosus* under natural conditions subsisted parasitically on fruiting bodies of "Tremellinen" occasion was taken whenever possible to observe the behavior of *Conidiobolus* mycelia when they encountered mycelia of basidiomycetes. Suitable opportunity for such observation was offered frequently in agar plate cultures that had been canopied with fine-textured debris found lodged basally between the crowded culms in old tussocks of some grasses, for in addition to conidia of *Conidiobolus* this kind of litter brought forth basidiospores that likewise were discharged early and gave rise to numerous clamp-bearing mycelia. No sign of parasitism was noted in extensive areas where the two types of mycelia were closely intermixed.

Brefeld's statement that *Conidiobolus utriculosus* subsists parasitically on fruiting bodies of "Tremellinen" was not amplified by any mention of observed abnormal changes in the fructifications harboring the entomophthoraceous fungus. Couch made no mention of any abnormality affecting the *Septobasidium* material from which he obtained *C. brefeldianus*. White (1937) did not record any unusual condition in the apothecia of *Peziza domiciliana* Cooke which when fastened above an agar plate for ascospore discharge gave him abundant growth of *Delacroixia coronata*. In these several instances of adventitious occurrence of readily culturable entomophthoraceous fungi the fruiting bodies need not have been infected, but may merely have been newly contaminated with conidia cast upon them from neighboring mycelia of the phycomycetous forms concerned. Other objects within range of spore discharge, as, for example,

chunks of bark, fragments of wood, pieces of twigs, and lumps of leaf residues, could well be expected to become contaminated no less frequently than fruiting bodies of ascomycetes and basidiomycetes, but in the past have less often been superposed over nutrient solutions and sterile agar plates. Conidia adhering to them have had correspondingly less opportunity to discharge secondary conidia down upon an expanse of favorable substratum that was being kept under close observation by an alert investigator. Presumably neither newly discharged conidia nor actively sporulating mycelia are necessary in canopied plate cultures, since here the moisture in the soft agar used as an adhesive matrix encourages germination of resting spores.

A SLOW-GROWING LUSTROUS DISJUNCTIVE SPECIES WITH SMALL CONIDIA AND SMALL ZYGOSPORES

An unobtrusive species of *Conidiobolus* which in the small size of its conidia recalls *C. minor* was obtained from leaf mold collected on January 22, 1952, in woods near Fort Myer, Arlington, Va. Its isolation in pure culture was attended with some little difficulty, as its vegetative growth is slow in comparison with that of several congeneric species among which it was intermingled. When cultivated on moderately firm maizemeal agar at temperatures near 20° C., it extends its mycelium radially only about 2.5 mm in 24 hours. To the naked eye an individual young mycelium appears markedly lustrous throughout. Later as the mycelium expands the lustrous effect often diminishes in the older central region while remaining undimmed toward the sharply demarcated margin. When viewed under the microscope the hyphae in the marginal zone show a considerable degree of prallelism in their arrangement. For the most part they vary in width from 4 to 7μ (Fig. 1, A, B). Although the individual filament shows noticeable variations in width along its slightly crooked course, pronounced fluctuations in this dimension are not usual, and only rather little tapering is observable near the bluntly rounded tip. Branching at the margin of an extensive mycelium is often characterized by angular relationships usual in dichotomy (Fig. 1, B). Cross-walls are laid down fairly early, the most distal septum in a filament being often found 150 to 200μ from the tip. Vacuolization near a newly inserted cross-wall (Fig. 1, B) commonly leads to complete emptying of a short hyphal part, and as evacuated portions of hyphal membrane usually soon fade from sight many living segments appear disjointed from their fellows. Some disjointed segments later produce short diverticulate branches (Fig. 1, C) and thus acquire an irregular, somewhat lobulate outline.

Asexual reproduction takes place by development of a single conidium from the individual hyphal segment. A hyphal segment formed on the surface of the substratum pushes forth into the air and toward the main source of light an erect or ascending branch which on attaining a length frequently of 20 or 25μ (Fig. 1, D, E) swells out markedly at its tip. The terminal swelling receives all the protoplasmic contents of the hyphal segment, and is then delimited as a conidium through deposition of a convex basal wall. Hyphal segments formed in submerged positions first extend a branch or prolongation through the ambient to the surface. When the surface is reached the elongating filament grows erectly or ascendingly into the air, its course, after an abrupt (Fig. 1, F) or more gradual (Fig. 1, G, H) upward turn, being directed toward the main source of light. The aerial prolongation then develops into a conidiophore in the same way as an aerial branch from a procumbent hyphal segment. Once the globose conidium has been cut off it exerts strong pressure upon the basal septum protruding convexly upward, until the peripheral membrane ruptures circularly along the circumference of the partition. Immediately the basal wall splits into two layers, and concomitantly the distal layer is everted with such briskness through pressure of the conidial protoplast that the spore is thrown off forcibly, though the trajectory on a flat level surface may not exceed a few millimeters.

While in their small dimensions the conidia (Fig. 1, I, a–i), even without repetitional development, rather closely approach those shown in Brefeld's illustration of *Conidiobolus minor*, they seem less elongated than Brefeld's specimens, and their basal wall appears more abruptly protuberant. They are commonly filled throughout with coarsely granular protoplasm, except that the basal protuberance usually shows more nearly homogeneous texture. They do not nor-

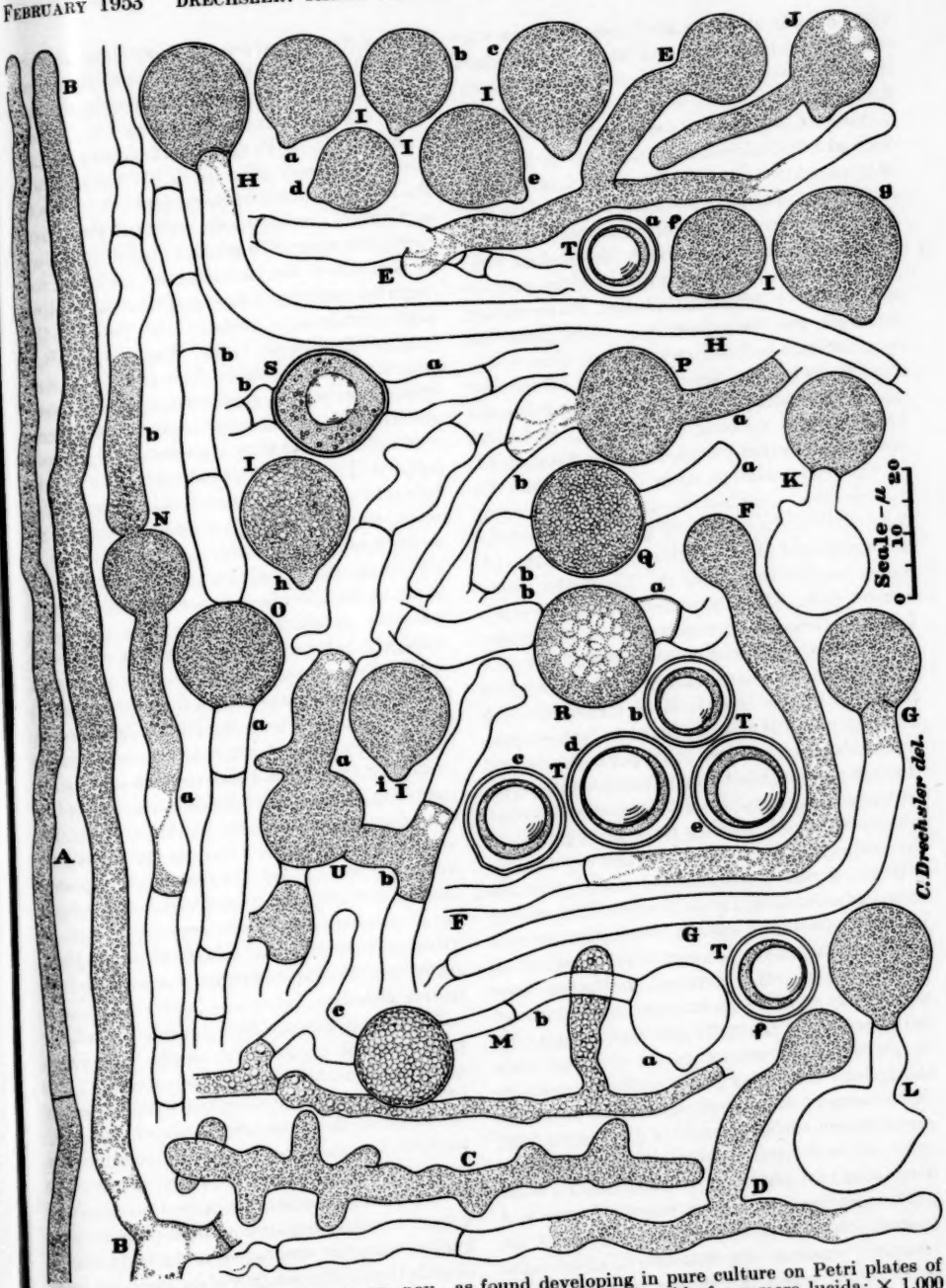


FIG. 1.—*Conidiobolus lamprauges*, sp. nov., as found developing in pure culture on Petri plates of maizemeal agar; all parts drawn at a uniform magnification with the aid of a camera lucida; × 1,000 throughout. Explanation of all parts given in text.

mally contain anything at all resembling the subspherical globules, about 3 to 5μ in diameter, shown in two conidia of *C. minor* depicted by Brefeld.

After falling on a moist substratum the discharged conidium often germinates by emission of a vegetative germ hypha (Fig. 1, J). If the substratum is already permeated with mycelium, repetitional development often ensues; the conidium putting forth a relatively short stout outgrowth on the tip of which it then gives rise to a secondary conidium (Fig. 1, K, L). The secondary conidium, like its parent, is normally delimited by a convexly arched basal partition (Fig. 1, K), and like its parent, again, is thrown off forcibly on circumscissile rupture of the peripheral membrane, abrupt splitting of the basal wall, and concomitant rapid eversion of the distal layer. In material mounted under a cover glass for microscopical examination all conidia, including those of secondary origin (Fig. 1, L), are usually not discharged after a normal manner, but commonly remain seated on the tip of the empty conidiophore, there gradually assuming their familiar proximally protuberant shape by gradually everting the entire basal septum.

Occasionally a conidium (Fig. 1, M, a) puts forth a germ tube (Fig. 1, M, b) that unites with a hyphal segment (Fig. 1, M, c) to form a zygospore. Much more often zygospores are formed through union of two hyphal segments that represent adjacent cells of the same mycelial filament. Onset of sexual reproductive development is first noticeable when one of the paired segments becomes locally swollen in the region near the crosswall separating it from its mate. The swelling increases steadily in size and soon appears as a globose enlargement. Apparently the adjoining portion of the other segment undergoes some widening at about the same time, but the increase in diameter here is usually less than 2μ, and only occasionally as much as 3μ. At a rather early stage the cross-wall separating the paired segments largely disappears, and granular protoplasm thereupon flows into the globose enlargement at both poles. Meanwhile the farther portions of both segments show increasing vacuolization, leading soon to progressive evacuation of contents. Successive stages in evacuation of the "female" segment—the segment (Fig. 1, N, a; O, a) within which the globose enlargement, or young zygospore, is formed—as well as of the "male" segment (Fig. 1, N, b; O, b) is frequently marked by deposition of a series of retaining walls. Transfer of protoplasm from the two segments is usually completed at nearly the same time, though in many instances the "female" segment (Fig. 1, P, a) appears somewhat slower than the "male" (Fig. 1, P, b) in contributing the last installment of its contents. As a rule the portions of membranous envelope successively evacuated soon collapse and vanish from sight, so that when the protoplasmic materials have migrated into the young zygospore, only relatively small membranous parts of the "female" (Fig. 1, Q, a; R, a) and "male" (Fig. 1, Q, b; R, b) segments remain visible. The portion of membranous envelope representing the "female" segment (fig. 1, S, a) shows no narrowing where it is attached, while that representing the "male" segment (Fig. 1, S, b) usually appears somewhat narrowed at its juncture with the zygospore, owing to the slight local enlargement of this segment at an early stage.

Transfer of protoplasm from the paired segments to the globose fusion cell is accomplished ordinarily in less than 2 hours. The subsequent changes in internal organization take place more slowly. By imperceptible stages the contents of the fusion cell change from a finely granular to a coarsely granular texture (Fig. 1, Q). Globules of increasing size appear near the center of the protoplast (fig. 1, R). These coalesce into a single reserve globule which at first is often of somewhat irregular shape (Fig. 1, S), but later, in the fully mature zygospore, has a sharply defined circular contour (Fig. 1, T, a–f). In the mature zygospore the thin wall originally present is found reinforced by a conspicuously thicker inner layer, and the living protoplasm forms a layer of nearly homogeneous consistency between the wall and the reserve globule.

The ripe zygospore here thus has much the same internal organization as the homologous spores of *Conidiobolus utriculosus* and *C. brefeldianus*. However the curious though specious resemblance that the sexual apparatus of *C. brefeldianus* bears to sexual reproductive apparatus of monosporous oomycetes is not evident in the present fungus. Even in the occasional instances where conjugation takes place between hyphal segments originating in separate hyphae (Fig. 1, U, a, b) fertilization of an oogonium by an antheridium is never closely simulated. Owing to early fusion of all paired hyphal segments any globose enlargement with conformation and

dimensions suggestive of an oogonium has very obviously received its contents in approximately equal measure from both segments.

A term (λαμπραυγης) meaning "lustrous" may serve conveniently as specific epithet of the fungus in bringing to mind the macroscopic appearance of its mycelium.

Conidiobolus lamprauges, sp. nov. Mycelium lente crescens (circa 2.5 mm in die), incoloratum, nitidum, aliquid ramosum, mox septatum, in hyphis 3–8μ (plerumque 4–7μ) latis constans; cellulis mycelii 35–200μ longis, saepius aliquid flexuosis, quandoque plus minusve disjunctis, interdum pluribus ramulis brevibus praeditis; hyphis conidiophoris simplicibus, erectis vel ascendentibus, in aere 25–100μ (vulgo 25–50μ) ad lucem protendentibus, interdum 5–15μ subter apicem parum inflatis, ibi 4–8μ latis, in apice unicum conidium ferentibus; conidiis se violenter abjicentibus, incoloratis, globosis, sed deorsum papilla rotundoconica vel hemisphaerica (1.5–4μ alta, 2.5–7μ lata) praeditis, 15–22μ (ex toto) longis, 12.5–20μ crassis, protoplasmatis dense granulosi repletis; zygosporis interdum e copulatione inter cellulam mycelii et tubum germinationis interdum e copulatione cellularum aliae atque aliae hyphae ortis, sed saepissime e copulatione cellularum duarum contiguarum ejusdem hyphae oriundis, hyalinis, globosis, plerumque 12–18μ crassis, in maturitate guttula nitida 7.5–11.5μ crassa et muro 1.3–2.2μ crasso praeditis.

Habitat in foliis quercorum putrescentibus in Arlington, Virginia.

Mycelium colorless, lustrous, at 20° C. growing radially about 2.5 mm in a day, moderately branched; assimilative hyphae somewhat flexuous, 3 to 8μ (mostly 4 to 7μ) wide, soon becoming divided by cross-walls at intervals of 35 to 200μ; the resulting hyphal segments sometimes remaining contiguous and at other times becoming disjointed, frequently after disjunction putting forth several short diverticulate or lobate branches. Conidiophores arising singly from individual hyphal segments, simple, colorless, projecting 25 to 100μ (commonly 25 to 50μ) erectly or ascendingly into the air, the aerial part always oriented toward the main source of light, often slightly widened and having a diameter of 4 to 8μ some little distance (mostly 5 to 15μ) below its tip whereon is borne a single conidium. Conidia filled with densely granular protoplasm, through sudden eversion of the upcurved basal membrane forcibly thrown off, colorless, globose, measuring 15 to 22μ in total length and 12.5 to 20μ in greatest width, the everted basal membrane forming a hemispherical or rounded-conical papilla 1.5 to 4μ high and 2.5 to 7μ wide at its origin. Conjugation sometimes taking place between a germ hypha and a hyphal segment, sometimes between 2 hyphal segments originating in separate mycelial filaments, but most often between 2 adjacent segments in the same mycelial filament; the fusion cell always initiated wholly within one of the gametangia, though in immediate proximity to the other gametangium; zygospore at maturity hyaline, globose, usually 12 to 18μ in diameter, containing an eccentrically placed reserve globule 7.5 to 11.5μ in diameter, provided with a wall commonly 1.3 to 2.2μ thick.

Occurring in decaying oak (*Quercus* spp.) leaves in woods in Arlington, Va.

A SPECIES WITH INCONSPICUOUS DISJUNCTIVE MYCELIUM AND PREDOMINANTLY DICLINOUS CONJUGATION

A species of *Conidiobolus* noticeably more robust than *C. lamprauges* was obtained from leaf mold kindly collected by A. W. Rakosy in Carroll County, N. H., late in September 1951. In maizemeal-agar plate cultures kept at temperatures near 20° C. it grows radially about 5 mm in 24 hours. Its submerged mycelium is inconspicuous, frequently being only indistinctly visible to the naked eye except at the sharply demarcated advancing margin, though it never vanishes from macroscopic sight as completely as the mycelium of two species of *Basidiobolus* that are widely distributed in leaf mold (Drechsler, 1952a). Viewed under the microscope an expanding mycelium of the fungus displays at its periphery terminal portions of many elongating hyphae mostly 6 to 8μ in width (Fig. 2, A). Very little tapering is observable below the bluntly rounded end. Formation of cross-walls ensues after about an hour, with the result that in many hyphae the most distal septum is found approximately 200μ from the tip. The segments delimited successively in the individual filaments vary moderately in length. Many are a little longer (fig. 2, J, a) or a little shorter (Fig. 2, J, b) than 100μ. As in *C. lamprauges* hyphal segments formed adjacent to one another may remain contiguous or may become disjointed through withdrawal of contents from one side of the separating cross-wall. After being delimited some segments will

widen perceptibly, then occasionally attaining a diameter in excess of 10μ (Fig. 2, B, a). In addition such stout segments not infrequently will put forth branches only 3 or 4μ wide (Fig. 2, B, b, c) and will thereby in small compass display opposite extremes in thickness of filamentous parts.

Asexual reproduction takes place abundantly in maizemeal agar cultures of the fungus. An individual hyphal segment that is immersed under the substratum extends a branch or prolongation which on reaching the surface soon turns upward and after widening rather markedly (Fig. 2, C, a) forms a globose swelling at its tip (Fig. 2, C, b). A hyphal segment that has originated in a procumbent hypha often puts forth a branch erectly or ascendingly into the air(Fig. 2, D, a). This aerial branch, much like the aerial termination of a branch from a submerged segment, widens out markedly and then forms at its summit a globose swelling (Fig. 2, D, b) into which are soon received the entire protoplasmic contents of the reproductive unit. Thereupon the arched septum that was being formed progressively at the base of the globose part—its formation proceeding from the periphery inward—during the later stages in the upward movement of protoplasm, is completed through deposition of wall material in the keystone region. A subspherical conidium is thus delimited, and soon afterwards is thrown off violently on sudden eversion of the distal layer of the arched partition. Since the aerial conidiophores, as in related species, are in conspicuous degree positively phototropic, the direction of discharge is consistently toward the main source of light.

The conidia of the New Hampshire fungus (Fig. 2, E, a–j) are in general larger than those of *Conidiobolus lamprauges*. Often the basal membrane here (Fig. 2, E, a–c) would seem to protrude less abruptly from the globose outline of the spore than in *C. lamprauges*, but often, too, the everted wall protrudes hardly less markedly (Fig. 2, E, d–h) than in the latter species. Usually the conidia of *C. lamprauges* seem filled throughout with coarsely granular protoplasm, whereas those of the New Hampshire fungus show commonly a relatively clear peripheral layer that surrounds a large mass of conglutinated lumps. The lumps, varying in width from 1.5 to 3.5μ, have an irregularly globose shape and thus somewhat resemble small oil globules, but unlike oil globules are little given to coalescence. A conidium may germinate vegetatively by putting forth a germ hypha (Fig. 2, F) or it may extend a conidiophore of variable length and produce a secondary conidium (Fig. 2, G, H).

Sexual reproduction is accomplished by conjugation so simple that the general appearance given differs little from that of chlamydospore development. In some instances two adjoining segments of the same hypha (Fig. 2, I, a, b) serve as gametangia, the fusion cell arising as a globose swelling situated wholly within one segment but lying immediately adjacent to the other segment. The separating cross-wall disappears almost entirely at an early stage, so that the incipient enlargement soon receives protoplasmic materials from both directions. As a rule the "male" segment (Fig. 2, I, b) may be distinguished from the "female" (Fig. 2, I, a) by its narrower attachment to the young fusion cell. Conjugation between adjacent segments apparently occurs less frequently in the present species than scalariform conjugation between segments of different hyphae (Fig. 2, J, a, b). Since in diclinous reproductive apparatus, too, the fusion cell is initiated at the place of hyphal union and wholly within one of the two gametangia (Fig. 2, K) the zygote commonly develops in a position partly or wholly within the hyphal connection. At the place of union the apposed portions of outer membranes dissolve almost completely, so that here, just as in monoclinous apparatus, protoplasm flows into the young fusion cell from the "male" segment (Fig. 2, J, b) about as freely as from the "female" segment (Fig. 2, J, a). Indeed, the "male" segment (Fig. 2, J, b) will often have contributed all its contents when its mate (Fig. 2, J, a) still retains a considerable quantity of protoplasm. Soon after portions of conjugating hyphal segments have been evacuated the empty tubular membrane, together with the septa contained in it, collapses and disappears from view. Thus, only an hour after movement of protoplasm began in the unit of sexual apparatus shown in Fig. 2, J, less than a third of the original membranous envelope of the "male" segment (Fig. 2, K, b) and scarcely half of the original envelope of the "female" segment (Fig. 2, K, a) remained visible. Forty minutes later all membranous parts of the "male" gametangium had vanished, and only two short membranous spurs (Fig. 2, L, a), both left by the "female" gametangium, could be seen attached to the developing zygospore, which now had not only laid down its definitive delimiting walls but had begun internal reorganization by elabo-

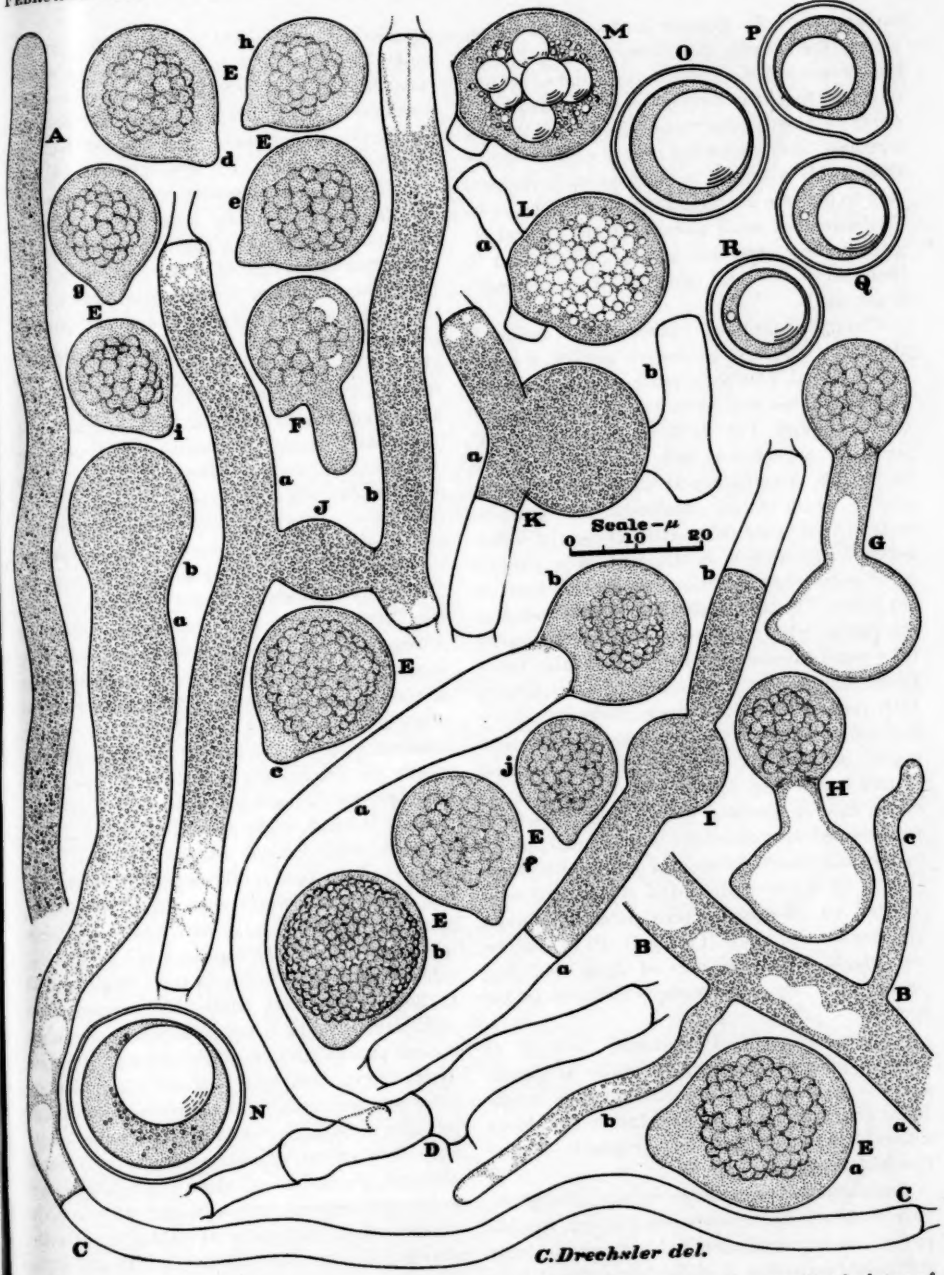


FIG. 2.—*Conidiobolus thromboides*, sp. nov., as found developing in pure culture on Petri plates of maizemeal agar; all parts drawn at a uniform magnification with the aid of a camera lucida; × 1000 throughout. Explanation of all parts given in text.

rating many oily globules in its central region. During the ensuing 30 minutes the longer of the two empty spurs vanished from sight, so that in little more than two hours after conjugation could be clearly ascertained the united hyphal segments were converted into a globose zygote (Fig. 2, M) with only a short empty cylindrical stub to indicate its origin from filamentous parts. The numerous small globules in the central region of the zygote had meanwhile coalesced to form seven or eight globules of considerably larger size.

Through continued coalescence of multiple globules a single large reserve globule is eventually formed. This body, much as in *Conidiobolus lamprauges*, lies well toward one side within the ripe zygospore (Fig. 2, N–R), a portion of its periphery approaching very close to the zygospore wall. Accordingly at maturity the protoplasm, which shows relatively few granules scattered in a limpid matrix of nearly homogeneous appearance, is disposed in a parietal layer pronouncedly thicker on one side than on the other. The thin envelope earlier surrounding the fusion cell is reinforced in the ripe zygospore by a much thicker inner layer presumably interpretable as the zygospore wall proper. Variability with respect to size is more moderate among zygospores of the New Hampshire fungus than might be inferred from the five individuals figured herein (Fig. 2, N–R), for one (Fig. 2, N) of the five—a specimen fully 27μ in diameter—was selected more especially to illustrate approximately maximum dimensions, while two others (Fig. 2, Q, R), each about 18μ in diameter, were selected to illustrate approximately minimum dimensions. Only two (Fig. 2, O, P) of the five individuals, with diameters of 23.5μ and 20μ, respectively, are of dimensions frequent in the species.

A term (*θρομβοειδης*) meaning "full of of clots or grains" may serve helpfully as specific epithet in recalling the conglutinated lumpy texture of conidial contents wherein the fungus differs markedly from the generally smaller *Conidiobolus lamprauges*.

Conidiobolus thromboides sp. nov. Mycelium circa 5 mm in die crescens, incoloratum, saepius parum conspicuum, aliquid ramosum, mox septatum, in hyphis 3–10.5μ (saepe 6–8μ) latis constans; cellulis assumentibus 50–200μ (saepe circa 100μ) longis, vulgo aliquid flexuosis, aliquando plus minusve disjunctis, interdum paucis angustis ramulis praeditis; hyphis conidiophoris simplicibus, erectis vel ascendentibus, in aere vulgo 35–150μ ad lucem protendentibus, sursum inflatis, ibi saepe 10–15μ latis, in apice unum conidium gignentibus; conidiis se violenter abjicentibus, incoloratis, globosis sed basi papilla rotundoconica vel hemisphaerica (2.5–6μ alta, 4–10μ lata) praeditis, plerumque ex toto 24–32μ longis, 19–26.5μ latis, in magna parte praecipue in medio glebarum protoplasmatis conglutinatarum repletis; zygosporis interdum e copulatione cellularum aliae atque aliae hyphae interdum e copulatione cellularum duarum contiguarum ejusdem hyphae oriundis, hyalinis, globosis, 17.5–27μ (plerumque 19.5–23.5μ) crassis, in maturitate guttula nitida 10–15μ crassa et muro magnam partem 2–2.5μ crasso praeditis.

Habitat in humo silvatica in New Hampshire.

Mycelium colorless, often rather inconspicuous, moderately branched, at temperatures near 20° C. growing radially about 5 mm in a day; assimilative hyphae somewhat flexuous, 3 to 10.5μ (mostly 6 to 8μ) wide, soon becoming divided by cross-walls at intervals of 50 to 200μ; the hyphal segments sometimes remaining contiguous but at other times becoming disjointed, and in some instances putting forth one or more narrow branches. Conidiophores arising singly from individual hyphal segments, simple, colorless, projecting 35 to 150μ (often about 100μ) erectly or ascendingly into the air, the aerial part oriented toward the main source of light, distally inflated, often measuring 10 to 15μ in greatest width, bearing a single terminal condium. Conidia forcibly thrown off through sudden eversion of the arched basal membrane, colorless, usually in large part filled with somewhat conglutinated protoplasmic lumps, globose, often measuring 24 to 32μ in total length and 19 to 26.5μ in greatest width, the everted basal membrane forming a hemispherical or rounded-conical papilla 2.5 to 6μ high and 4 to 10μ wide at its origin. Conjugation most usually taking place between two hyphal segments originating in separate mycelial filaments but sometimes taking place between two adjacent segments in the same filament; the fusion cell always initiated wholly within one segment and in immediate proximity to the other; zygospore at maturity hyaline, globose, 17.5 to 27μ (mostly 19.5 to 23.5μ) in diameter, containing a very eccentrically placed reserve globule 10 to 15μ in diameter, and provided with a wall for the most part 2 to 2.5μ thick.

Occurring in leaf mold in Carroll County, N. H.

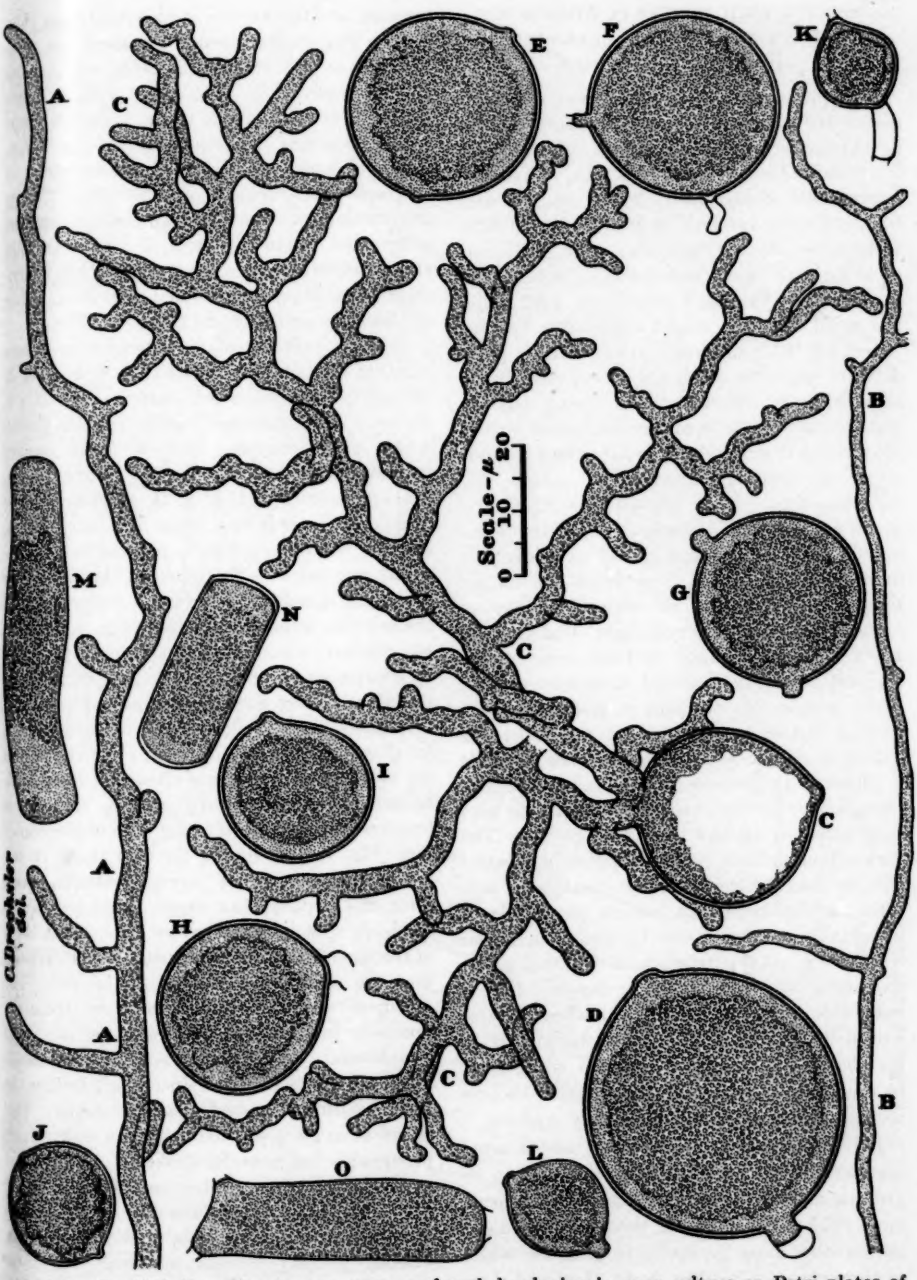


FIG. 3.—*Conidiobolus adiaeretus*, sp. nov., as found developing in pure culture on Petri plates of maizemeal agar; all parts drawn at a uniform magnification with the aid of a camera lucida; × 1000 throughout. Explanation of all parts given in text.

A SPECIES WITH ROBUST CONIDIOPHORES ARISING FROM RICHLY BRANCHED DELICATE MYCELIUM

An entomophthoraceous fungus especially distinctive in its vegetative stage was first found developing in agar plate cultures prepared with leaf mold collected near Farmer, N. C., in December 1951. Subsequently it was obtained also from leaf mold gathered in eastern central New Hampshire late in September 1951; from leaf mold gathered in oak woods along Lubbers Run in Arlington, Va., on February 28, 1952; from leaf mold collected near Criglersville, Va., on March 23, 1952; and from various kinds of plant detritus taken up in several places near Beltsville, Md., at different times during January and February 1952. On maizemeal agar of moderate firmness it grows slowly, producing a lustrous mycelium somewhat more nearly opaque and correspondingly more conspicuous than the mycelium of *Conidiobolus lamprauges*. Before an individual mycelium has spread extensively it produces conidiophores from which conidia are thrown for distances of several millimeters toward the main source of light. Falling on a moist substratum many of these conidia give rise collectively to scattered subsidiary mycelia which soon occupy the area completely thereby barring further growth in that region by the parent mycelium. As the same sequence of events is repeated another array of mycelia come into being a little farther onward, which in their turn form a barrier against those to their rear. The fungus thus spreads over an expanse of substratum by establishing numerous demarcated mycelia that in large part remain discernible as individuals and therefore in the end often appear collectively as a patchwork of lustrous areas. Ordinarily no similar patchy or dappled effect is noticeable in related fungi, for while these likewise habitually colonize adjacent areas, their outlying mycelia—often from the first too transparent to stand out individually in clear relief—become merged indistinguishably when they coalesce.

Under a microscope an extensive unobstructed mycelium of the present fungus shows along its growing margin numerous hyphae that measure mostly 3.5 to 4μ in width, though in the distal portion they taper gradually to an apical width of approximately 3μ (Fig. 3, A). Here and there in older cultures narrower hyphae are found which over considerable stretches may not exceed 2μ in width and, indeed, may in some portions measure as little as 1.8μ in this dimension (Fig. 3, B). The greatest width sustained for some distance in the stouter filaments would seem approximately 4.5μ (Fig. 4, A). Only rather moderate development of lateral branches occurs at the margin of an extensive mycelium (Fig. 3, A). Abundant branching is, however, usual in the earlier development of a mycelium from a germinating conidium. The ramified procumbent outgrowths shown in Fig, 3, C, represent only about one-twentieth of the entire three-dimensional hyphal system formed within a radius of 150μ from an individual spore.

In older portions of an extensive mycelium many of the lateral branches (Fig. 4, A, r; B, r) are empty of protoplasmic contents and accordingly are found delimited basally from the parent hypha by a retaining wall. A much smaller number continue growth distally to give rise to conidiophores (Fig. 4, A, a; B, a; C, a). As the conidiophores here are often 20μ or more in greatest width they offer a pronounced dimensional contrast with the mycelial filaments. The prolonged transfer of granular materials into the growing terminal conidium (Fig. 4, B, b) is not regularly accompanied, as in related species, by evacuation of a particular hyphal segment, or of any adjoining portion of axial hypha. When eventually the conidiophore is delimited by a basal septum (Fig. 4, C, a) the axial hypha and the connecting branch are often still filled with granular protoplasm. An arched septum is progressively laid down at the base of the conidium (Fig. 4, C, b) during the later stages in the upward movement of living contents. Soon after the septum has been completed, it is suddenly split into two layers. The distal layer at the same time is briskly everted, with the result that the conidium is thrown off forcibly. The distances spores are propelled here seem appreciably less than in *Delacroixia coronata* and *Conidiobolus brefeldianus*. Feebler propulsion might readily be expected since in my fungus the basal septum is arched less prominently, and therefore in being everted delivers a shorter and presumably less powerful stroke.

The largest of the primary conidia (Fig. 4, D) produced by the fungus measure approximately 46μ in total length and 45μ in width. Well developed primary conidia commonly vary between 30 and 40μ in both dimensions (Fig. 4, E, F). Individuals less than 25μ (Fig. 4, G–M) would mostly seem to represent products of repetitional development. Such development

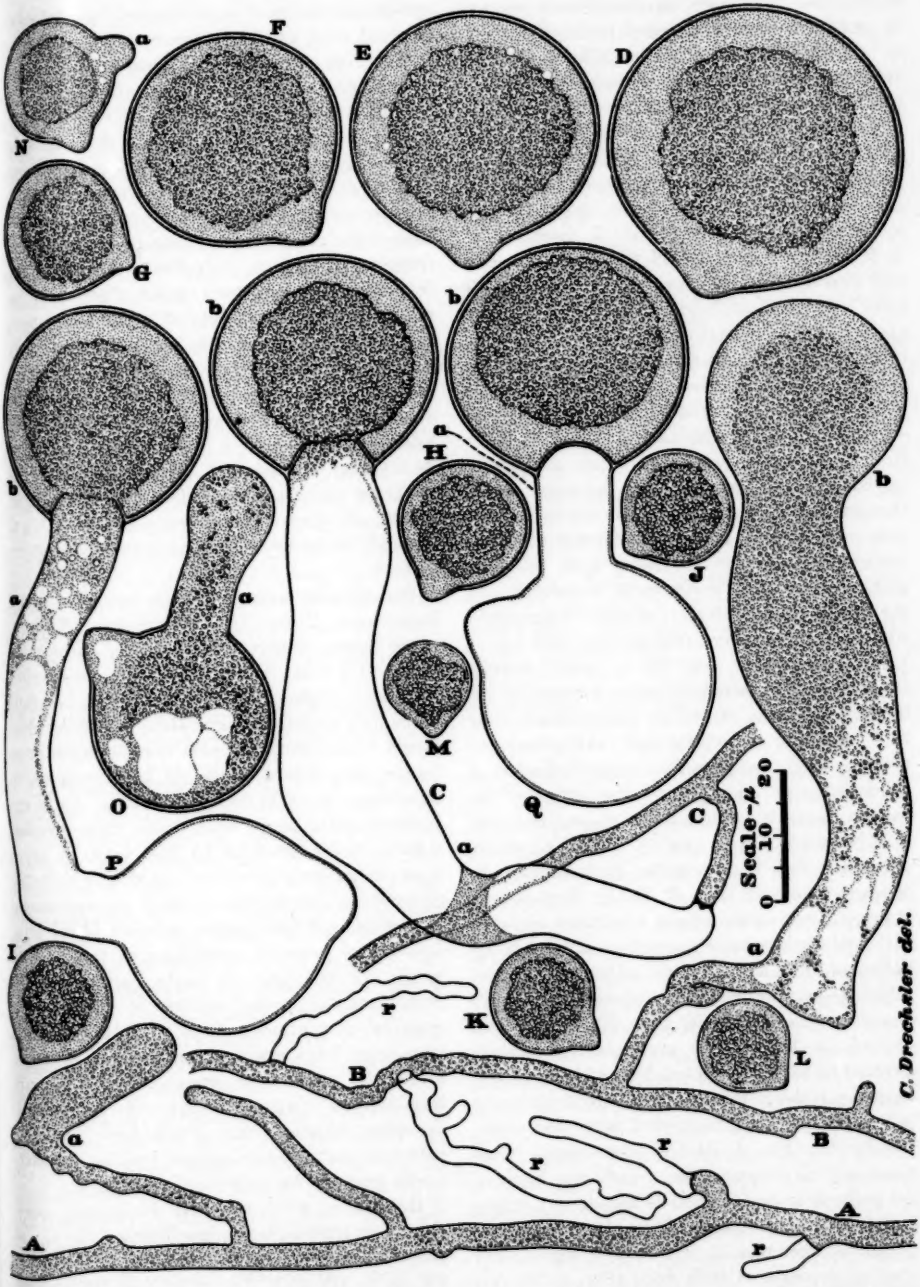


FIG. 4.—*Conidiobolus adiaeretus*, sp. nov., as found developing in pure culture on Petri plates of maizemeal agar; all parts drawn at a uniform magnification with the aid of a camera lucida; × 1000 throughout. Explanation of all parts given in text.

takes place very freely in the present species. A protuberance is bourgeoned forth (Fig. 4, N, a) which after some elongation (Fig. 4, O–Q: a) swells distally to form a globose secondary conidium (Fig. 4, P, b; Q, b) that is thrown off forcibly in the same way as was its parent. As the reduction in size incurred in one repetitional generation is not especially pronounced in instances where the conidiophorous outgrowth is of moderate length, many secondary conidia (Fig. 4, P, b; Q, b) measure 30 to 40μ in diameter and thus after discharge are not distinguishable from well developed primary conidia. With respect to their internal organization the conidia, both large and small somewhat resemble those of *Conidiobolus thromboides* in having a rather dense conglutinated central mass of protoplasm surrounded by a hyaline parietal layer. However the central mass here is less coarse in texture, its constituent particles being granules rather than lumps. When conidia are mounted in moist agar under a cover glass and subjected to microscopical examination in strong light the conglutinated mass soon contracts noticeably and the clear parietal layer becomes interspersed with vacuoles of increasing number and size.

At temperatures near 20° C. aerial conidia are the only reproductive bodies formed by the fungus. On being stored at temperatures near 7° C. tubes of maizemeal agar well permeated with mycelium will permit copious formation of chlamydospores mainly under the surface of the culture medium. Since these chlamydospores, usually of globose or prolate ellipsoidal shape, very often show two truncated protuberances in opposite positions (Fig. 3, D–G), they appear largely of intercalary origin. Specimens showing only one protuberance suggestive of hyphal attachment (Fig. 3, H, I) seem of terminal origin. Most chlamydospores, like most conidia, vary in diameter from 25 to 40μ .(Fig. 3, D–H). Small individuals (Fig. 3, I–L), corresponding in their dimensions to conidia derived through successive repetitional development, are usually found only in meager quantity. Somewhat indurated cylindrical cells (Fig. 3, M–O), often about three times as wide as unmodified assimilative hyphae, are perhaps to be regarded as imperfectly differentiated chlamydospores. They often show conglutinated granules in the middle region and clear protoplasm at both ends (Fig. 3, M, N). In well differentiated globose chlamydospores, much as in conidia, a relatively large conglutinated granular mass is surrounded by a parietal layer of more nearly transparent protoplasm.

The fungus is referred to *Conidiobolus* since it grows well on ordinary culture media and in its asexual reproduction does not differ very widely from *C. utriculosus*, the type species of that genus. Its mycelium differs conspicuously from that of *C. utriculosus*, *C. brefeldianus*, *C. lamprauges*, and *C. thromboides* not only in the slenderness of the component hyphae but also in their frequently copious branching. Although the fungus forms numerous septa that serve as retaining walls in closing off evacuated lateral branches from the living axial hyphae, early deposition of cross-walls to separate adjacent living segments—a very usual feature in the vegetative growth of other readily cultivable Entomophthoraceae—is not characteristic of its mycelial development. In agar plate cultures it shows no disjunction of living hyphal segments. A term (*αδιαιρετος*) meaning "undivided" is therefore deemed a suitable specific epithet.

Conidiobolus adiaeretus, sp. nov. Mycelium lente (circa 2 mm in die) crescens, nitidum, conspicuum; hyphis assumentibus, incoloratis, vulgo 1.8–4.5μ latis; interdum mediocriter interdum copiose ramosis, ramulis brevibus saepe mox inanitis denique ab hyphis viventibus longis septo finitis; hyphis conidiophoris incoloratis, simplicibus, erectis vel ascendentibus, in aere vulgo 50–100μ (rarius 100–250μ) ad lucem protendentibus, rectis vel curvatis, vulgo speciose inflatis, 8–25μ (saepius 15–23μ) latis, in apice unum conidium gignentibus; conidiis se violenter adjicentibus, incoloratis, globosis vel applanato-ellipsoideis sed basi papilla rotunda (2–6μ alta, 5–17μ lata) praeditis, plerumque ex toto 15–46μ longis, 13–45μ latis, in parte parietem juxta protoplasmatis hyalini repletis in parte media granulis conglutinosis farctis; chlamydosporis plerumque intra materiam permeatam oriundis, incoloratis, plerumque intercalaribus, interdum terminalibus, vulgo globosis vel elongato-ellipsoideis, 15–45μ longis, 3–40μ latis, in parte parietem juxta protoplasmate hyalino in parte media granulis conglutinosis instructis.

Habitat in foliis arborum (praecipue quercorum) putrescentibus prope Farmer, N. C., et prope Beltsville, Md., et prope Criglersville, Va., et in Arlington, Va., et in New Hampshire, etiam in aliis materiis plantarum putrescentibus prope Beltsville, Maryland.

Mycelium growing slowly (about 2 mm in 24 hours at 20° C.), lustrous, conspicuous; assimilative hyphae colorless, mostly 1.8 to 4.5μ wide, sometimes moderately and sometimes abundantly branched, the shorter branches often emptied early of their protoplasm and then delimited basally by a retaining wall; conidiophores colorless, simple, straight or curved, projecting 50 to 200μ (or more) erectly or ascendingly into the air, the aerial part oriented toward the main source of light, often pronouncedly inflated, 8 to 25μ (commonly 15 to 23μ) in greatest width, bearing a single conidium at the tip; conidia forcibly thrown off through sudden eversion of the arched basal membrane, colorless, containing a parietal layer of hyaline protoplasm which surrounds a large irregular mass of conglutinated granules, subspherical or sometimes oblate ellipsoidal in general shape, measuring 15 to 46μ in total length and 13 to 45μ in width, their everted basal membrane forming a rounded papilla 2 to 6μ high and 5 to 17μ wide; chlamydospores formed mainly within the substratum, borne intercalarily or terminally, mostly globose or ellipsoidal, 15 to 45μ long and 13 to 40μ wide, colorless, containing a large central mass of conglutinated granules that is surrounded by a parietal layer of hyaline protoplasm.

Occurring in decaying leaves of trees (especially of *Quercus* spp.) in woods near Farmer, N. C.; near Beltsville, Md.; near Criglersville, Va.; in Arlington, Va.; in Carroll County, N. H.; and also in other decaying plant materials near Beltsville, Md.

REFERENCES

BREFELD, O. Conidiobolus utriculosus *und* minor. Unters. Gesammtg. Mykologie **6:** 35–72, 75–78, pl. 3–5. 1884.

COUCH, J. N. *A new* Conidiobolus *with sexual reproduction*. Amer. Journ. Bot. **26:** 119–130. 1939.

DRECHSLER, C. *Widespread distribution of* Delacroixia coronata *and other saprophytic Entomophthoraceae in plant detritus*. Science **115:** 575–576. 1952.

———. *Two species of* Basidiobolus *widely distributed in leaf mold*. (Abstract) Phytopathology **42:** 341. 1952a.

GILBERT, E. M. *A peculiar entomophthorous fungus*. Trans. Amer. Micr. Soc. **38:** 263–269, pl. 27, 28. 1919.

WHITE, W. L. *Note on* Conidiobolus. Mycologia **29:** 148–149. 1937.

BOTANY.—*The species of* Pittosporum *in Formosa*.

HUI-LIN LI, Morris Arboretum, University of Pennsylvania.

There are five species of the genus *Pittosporum* on the island of Formosa. Two of them are more or less widespread in Formosa and extend also widely on the mainland of China. One is confined to the southern part of the island, and another is found only on the small island of Botel Tobago. These two southern species described as endemic to Formos are actually found to be only the northernmost populations of two widely distributed Philippine species. A fifth species is endemic to Formosa at high altitudes only.

Recently a treatise on the *Pittosporum* species of eastern Asia was published by M. Gowda (*The genus* Pittosporum *in the Sino-Indian Region*. Journ. Arnold Arb. **32:** 263–343. 1951). Six species[1] from Formosa are accounted for, his findings being very much at variance with those of the present writer. Gowda considers the Formosan plant known as *P. makinoi* to be distinct, but in the present study it is treated as conspecific with the widely distributed *P. tobira*. For *P. illicioides* treated as a single species here, two separate species under different names are recognized by Gowda, one described as new. Gowda did not recognize the identity and relationship with Philippines species of the two southern species of Formosa. As *Pittosporum* is primarily a southern genus, the nature of some of the southernmost species in Formosa, on the Chinese mainland, and in India cannot be properly elucidated without consulting related species of the southern islands of Asia.

Selected specimens are cited from the U. S. National Herbarium, Smithsonian Institution, indicated as (US), and the herbarium of the National Taiwan University, Formosa, indicated as (NTU).

[1] On page 282, Gowda mentions that there are five species known from Formosa. He inadvertently left out his own new species, *P. sahnianum*, which he credited to Formosa on the basis of *Wilson 11066*.

KEY TO THE FORMOSAN SPECIES

A. Flowers, few, fasiculate, from axils of upper leaves, with slender peduncles; fruit often solitary.....1. *P. illicioides*
AA. Flowers or fruits usually many, in terminal racemes or spikes.
B. Leaves broadest at or below middle, apex acute; fruit small, less than 1 cm across.
C. Leaves large, 10–15 cm long; fruit very small, about 6 mm across
2. *P. daphniphylloides*
CC. Leaves smaller, about 6–9 cm long; fruit larger, about 8 mm across
3. *P. pentandrum*
BB. Leaves usually broadest above middle, apex obtuse to rounded; fruit large, 1.5 cm or more across.
C. Leaves 6–8 cm long and 2–3 cm broad; fruit about 1.5 cm across.....4. *P. tobira*
CC. Leaves larger, 8–12 cm long, 3–5 cm broad; fruit about 2 cm across
5. *P. littorale*

1. **Pittosporum illicioides** Makino in Bot. Mag. Tokyo **14:** (31). 1900; Migo in Journ. Jap. Bot. **16:** 566. 1940.
Pittosporum oligocarpum Hay. in Journ. Coll. Sci. Univ. Tokyo **30** (1): 35. 1911 (Mat. Fl. Formos.); Icon. Pl. Formos. **1:** 63. 1911; Kanehira, Formos. Trees **45:** 1917, rev. ed. 249. *f. 193*, 1936; Gowda in Journ. Arnold Arb. **32:** 304. 1951.
Pittosporum oligospermum Hay. Icon. Pl. Formos. **3:** 31. 1913, *ibid.* **5:** 7. *f. 2.* 1915.
Pittosporum sahnianum Gowda in Journ. Arnold Arb. **32:** 305. 1951. *Syn. nov.*

Widely distributed and common on the Chinese mainland and in Formosa, at medium to high altitudes.

Formosa: Arisan, *E. H. Wilson 9774* (US); Seisui, prov. Karenko, *E. H. Wilson 11066* (US); Sikayotaizan, *G. Masamune 1296* (NTU).

Gowda overlooked Migo's paper which also considers *P. glabratum* Lindl. as confined to southern China, while the plant of central China, generally referred to *P. glabratum*, is the same as *P. oligocarpum* Hay. of Formosa and *P. illicioides* Makino of Japan. Gowda maintains the last two as two distinct species, although for *P. illicioides* he had access to only a sterile twig.

For this widespread and common plant, Gowda recognizes two species as occurring on both the Chinese mainland and in Formosa: *P. oligocarpum* Hay. and *P. sahnianum* Gowda. The first is found mainly in Formosa but is also recorded from Chekiang and Kiangsi. The second is widespread on the Chinese mainland but is also credited to Formosa on the basis of *Wilson 11066*. In his key the two species are differentiated mainly by the size of the fruit as follows:

"Capsules extremely small, 6 mm long, without abruptly constricted stipe; inflorescence a simple cyme; flowers small, petals usually 6-7 mm long; pedicels extremely slender, less than 1 mm thick.....*P. oligocarpum*
Capsules large, 10 mm long; stipe abruptly constricted; inflorescence a cluster of single flowers; flowers large, petals usually 8 mm long; pedicels more than 1 mm thick.....*P. sahnianum*"

If one studies the actual specimens, it is clear that these differences are exaggerated. Gowda's own descriptions do not agree with his key. He gives no measurement for the capsule of *P. sahnianum* in the description of the species, but for *P. oligocarpum*, the size of the capsule is given as 7–9 mm instead of 6 mm long and it is "without or with inconspicuous stipe" instead of without stipe as mentioned in his key. Among the numbers he cited for *P. sahnianum* that are available to me, such as *Chiao 14798*, *Wilson 1674*, *Ching 1455*, *2264*, etc., there appears considerable variation in the size of the capsule, in part apparently due to age, but evidently also due to its inherent variable nature. These capsules vary from 6 to 12 mm in length. The stipe at the base is generally conspicuous but varies considerably in length and diameter. The pedicles are often very slender, comparable to those of *P. oligocarpum* from Formosa. Specimens of *P. oligocarpum* cited by Gowda from Chekiang, *Ching 1874*, and from Formosa, *Wilson 9774*, have capsules varying from 6–9 mm long and also with a distinct but short stipe. It is true that the Formosan plants have generally smaller capsules, but the size of capsule alone does not indicate species differentiation in such a variable and widely distributed species. *Wilson 11066* from Formosa, cited by Gowda as representing *P. sahnianum*, has capsules measuring about 10 mm long. But compared with *Wilson 9774*, also from Formosa but cited by him as *P. oligocarpum*, besides the very slight difference in the size of the fruits, there is not the slightest difference in other characters that can separate the two specimens specifically. Clearly only one species is represented in Formosa, and this is evidently also conspecific with the plants on the mainland of China known as *P. glabratum* auct. non Lindley and in Japan known as *P. illicioides* Makino. It seems that on the whole

too many species are recognized by Gowda in his treatment of the genus in eastern Asia, with over-emphasis on some minor variations probably of no genetic significance.

2. **Pittosporum daphniphylloides** Hay. in Journ. Coll. Sci. Tokyo **30** (1): 34. 1911; Icon. Pl. Formos. **1:** 65. 1911; *ibid.* **5:** 6. 1916; Kanehira, Formos. Trees, rev. ed. 248. *f. 191.* 1936; Gowda in Journ. Arnold Arb. **32:** 336. 1951.

Formosa, at high altitudes, central and eastern part of the island; usually epiphytic.

Formosa: Arisan, *E. H. Wilson 10803* (US); Taito, *Mori 11548* (photo of isotype, US).

3. **Pittosporum pentandrum** (Blanco) Merr. in Govern. Lab. Publ. (Philip.) **27:** 19. 1905.
Aquilaria pentandrum Blanco, Fl. Philip. 373. 1837.
Pittosporum formosanum Hay. in Hay. & Matsum. in Journ. Coll. Sci. Tokyo *22:* 32. *f. 4.* 1906 (Enum. Pl. Formos.); Kanehira, Formos. Trees, rev. ed. **249.** *f. 192.* 1936; Gowda in Journ. Arnold Arb. **32:** 327. 1951. *Syn. nov.*
Pittosporum undulatum sensu Hay. in *op. cit.* 33, non Vent.

Southern Formosa, Hunchuen Peninsula, and Botel Tobago, along the seashore; also in Indo-China.

Formosa: Takao, *A. Henry 1058* (US), *E. H. Wilson 9853* (US); Bankinsing, *A. Henry 48* (US); Kuraru, Prov. Koshun, *E. H. Wilson 11001* (US).

This species occurs commonly in the southernmost part of Formosa and on the island of Botel Tobago, along the seashore. The Formosan specimens are doubtless conspecific with *P. pentandrum*, a very common and widely distributed species of the Philippine islands. Gowda records *P. formosana* as also occurring in Tonkin, Indo-China. A variety of this species with pubescent ovary occurs in Tonkin and Hainan: *P. pentandrum* (Blanco) Merr. var. *hainanense* (Gagnepain) comb. nov. (*P. formosanum* var. *hainanense* Gagnepain, Fl. Gén. Indo-Chine **1:** 238. 1909, Suppl. **1:** 214. 1939).

4. **Pittosporum tobira** Ait. Hort. Kew, ed. 2, **2:** 27. 1811; Kanehira, Formos. Trees, rev. ed. 250. *f. 192.* 1936.
Pittosporum makinoi Nakai, Fl. Sylv. Korea. **21:** 84. 1936; Gowda in Journ. Arnold Arb. **32:** 311. 1951. *Syn. nov.*
Pittosporum tobira var. *calvescens* Ohwi in Journ. Jap. Bot. **12:** 311. 1936.

Widely distributed in eastern Asia; very common along the coastal region in the northern part of Formosa.

Formosa: Keelung, *T. Tanaka & Y. Shimada 11023* (US); Toyen, Sinchikushu, *T. Tanaka & Y. Shimada 13539* (US); Sozan, Taihoku, *E. H. Wilson 10790* (US); Silin, Taipeh, *H. Keng 1034* (US); Sin-chow, prov. Karenko, *E. H. Wilson 11094* (US); Shusin to So-o, Prov. Taihoku, *E. H. Wilson 10285* (US).

The Formosan plant is variously considered as conspecific with the widely distributed *P. tobira*, as by Kanehira, as a variety of the latter species, as by Ohwi, and as a distinct species, as by Nakai. Gowda follows Nakai in calling the Formosan plant a distinct species. Ohwi considers his variety as different from the typical form of *P. tobira* in the less pubescent habit and the slightly pilose ovary. Gowda says that the Formosan plant *P. makinoi* very closely resembles *P. tobira*, differing in having a glabrous inflorescence. The inflorescence is described by him as "usually glabrous," but in his key it is given as "inconspicuously pilose." In the original description of Nakai, the inflorescence is described as minutely and sparsely pilose. Actually the inflorescence is in general pubescent, as in *P. tobira* from other regions, such as Japan, Korea, and China. Gowda also tries to differentiate the two on the basis of their leaf shape, but his characterizations: "leaves obovate, broadest above middle and abruptly rounded at apex, frequently emarginate" for *P. tobira* and "leaves usually obovate, broadest above the middle, usually rounded at apex" for *P. makinoi*, show that leaf shape cannot be successfully utilized. Clearly this Formosan plant, common especially along the coastal regions in the northern parts, is conspecific with the widespread species *P. tobira*, of China, Japan and Korea, also mainly of the coastal regions.

Gowda is also inconsistent in his emphasis on the pubescence of the inflorescence, as he describes two varieties with glabrous inflorescence, var. *fukienense* from Fukien and var. *sukuraii* from the Bonin islands, under the species *P. tobira*, which is considered by him as different from *P. makinoi* and others in having the character of the inflorescence "very conspicuously tomentose".

5. **Pittosporum littorale** Merr. in Philip. Journ. Sci. **5.** Bot.: 179. 1910.

Pittosporum viburnifolium Hay. Icon. Pl. Formos. **3:** 32. 1913; Kanehira, Formos. Trees, rev. ed. 251. *f. 195.* 1936; Gowda in Journ. Arnold Arb. **32:** 323. 1951. *Syn. nov.*

Formosa, in Botel Tobago Island only, and the Philippines.

This species is known in Formosa only from Botel Tobago Island and is the same as *P. littorale* of the Philippines; several specimens of the latter, including *Merritt 9845*, isosyntypes, are available for comparison. The oblanceolate and obtuse leaves, large flowers, and the subglobose 2-valved capsules are distinctive characteristics of the species. The plants grow in thickets along the seashore.

ENTOMOLOGY.—*The Diptera collected on the Cockerell and Hubbell Expeditions to Honduras: Part II, Asilidae.*[1] MAURICE T. JAMES, State College of Washington.

The present paper, based on material collected in Honduras by Prof. and Mrs. T. D. A. Cockerell during the winter of 1946–47 and by Dr. T. H. Hubbell in 1923 and again in 1948, lists 37 species of Asilidae from Honduras, of which 8 are new and 2 are at least in part redescribed. I am indebted to Dr. A. Earl Pritchard who, though he could not critically review the manuscript, read it and gave me several valuable suggestions.

Psilonyx (*?macropygialis* (Williston)), 1901. Biologia Centrali-Americana, Diptera, **1:** 301 (*Leptogaster*). Reference is made with doubt to this species because the specimen before me lacks the apical half on the abdomen. Aguan River Valley, Copete farm, April 10, 1923 (T. H. Hubbell), no. 355, 1 male.

Leptogaster spp. Three specimens, representing three species, from Zamorano, can not safely be referred to known species nor described as new, because of the condition of the literature in this group.

Asilus tuxpanganus Bellardi, 1862. Saggio di ditterologia Messicana, Appendice: 22. Escuela Agrícola Panamericana, Zamorano, July 24, 1948 (T. H. Hubbell), plain, Yeguare River, no. 141, 1 male, 1 female; same, July 1, 1948, roadside, no. 10, 1 male; same, creek bank, July 19, 1948, no. 103, 1 male.

Asilus tenebrosus Williston, 1901. Biologia Centrali-Americana, Diptera, **1:** 328. Cerro Uyuca, Dept. Morazán, July 24, 1948 (T. H. Hubbell), 5,900–6,100 feet, cloud forest, no. 139, 1 male.

Ommatius near *marginellus* (Fabricius), 1781. Species insectorum **2:** 464 (*Asilus*). Dos Aguas, 8 km west, October 27, 1946 (Cisneros), 1 male; Río Claura, April 12, 1923 (T. H. Hubbell), no. 245, 1 male.

Ommatius parvus Bigot, 1875. Ann. Soc. Ent. France (5) **5:** 247. Escuela Agrícola Panamericana, Zamorano: July 1, 1948 (T. H. Hubbell), 2,600 feet, roadside, no. 10, 5 males, 7 females; August 2, 1948 (Hubbell), 2,700 feet, oak woods, no. 180, 2 males; July 22, 1948 (Hubbell), 2,650 feet, herbage and brush, no. 125, 1 male, 2 females; July 8, 1948 (Hubbell), 2,550 feet, plain, Yeguare River, no. 39, 2 males, 2 females; July 2, 1948 (Hubbell), plain, Yeguare River, 2,550 feet, no. 18, 1 female; July 19, 1948 (Hubbell), 2,600 feet, creek bank, no. 103, 1 female; July 29, 1948 (Hubbell), 2,650 feet, thicket, 1 female; July 10, 1948 (Hubbell) 2,700 feet, llanos, no. 50, 1 male. Los Llanos, Dept. El Paraíso, E. slope Zamorano Valley, Guinope Road, July 9, 1948 (Hubbell), 3,000 feet, no. 44, 1 male, 2 females.

Eicherax flavescens, n. sp.

A small species with predominantly silvery pile and silvery to yellowish pollen, predominantly yellow legs, and the body ground color tending to yellow; one pair of scutellar bristles.

Male.—Head black, densely covered with pollen, which is yellowish on the front and vertex and otherwise silvery. Facial prominence covering lower two-thirds of face, not especially strong; mystax dense, white except two small bristles above; a few black and white bristles and hairs along the ocular orbits, to the side of and above the antennae; ocellar bristles small, ocellar triangle small and otherwise devoid of vestiture; beard and postocular fringe white; six bristles on each side of upper part of occiput, mostly black. Antennae black with short black setulae; ratio of first, second, and third segments and arista 8: 4: 10: 15. Palpi black, black-haired.

[1] For part I of this series, see Pan-Pac. Ent. **26** (2): 86–90.

Proboscis shining black, in some reflections bluish black, with long white hairs below.

Thorax black, the ground color becoming yellowish to reddish on the humeri, postalar wall and parts of the postalar callus, metanotal slopes, and posterior half of pleura approximately behind a line drawn along the posterior margin of the mesopleura; scutellum and metanotum black. Pollen of mesonotum, uppermost parts of mesopleura, and scutellum yellowish; a geminate mid-dorsal vitta and an adjacent oval area on each side, interrupted by the suture, more brownish pollinose, in places subshining; bristles and hairs of mesonotum, except a scattered few before the suture, and hairs of uppermost parts of mesopleura black; those of scutellum and otherwise of pleura white; scutellum with a pair of bristles and with short scattered hairs. Legs predominantly yellow; coxae in part black; each femur with a broad black dorsal vitta; tibiae, especially hind pair, blackened at apex; tarsi with fifth tarsomeres and narrow apices of the others brownish. Leg bristles apparently of variable color, but apparently wholly white on coxae, wholly white or almost so on femora, mixed black and white on tibiae, and predominantly black on the tarsi. Venation normal for the genus, that is, of the *Asilus* type; wing subhyaline, clouded at the apex (roughly beyond base of second submarginal); veins yellow; halteres yellow.

Abdomen chiefly reddish yellow in ground color, the second, sides of the first, and base of the third terga, and the apical half of the eighth sternite blackish; some short black inconspicuous hairs medially on the terga and dorsally on the hypopygium, vestiture otherwise white; pollen yellowish dorsally, white to silvery ventrally; two to three white bristles on each posterior angle of the terga, but these becoming small and inconspicuous beyond tergum 3; first three sterna each with several long bristle-like setulae; segments seven and eight very short. Genitalia (Fig. 1) large, eighth sternite strongly produced posteriorly, at base with a crest of appressed white hairs and with the hairs to the side of and behind this crest directed backward to form a broad, rather loose, silky tuft.

Length, 10 mm.

Female.—Mystax not as dense as in the male; hairs all white but the bristles on its upper part and one to two on each side of the oral margin black. Abdomen predominantly black, reddish only in spots on the sides of the segments and toward their apices. Eighth and ninth segments shining black, eighth longer than the preceding segments, relative lengths of segments 6 to 9 inclusively 25: 25: 35: 20; eighth segment broad at its base but soon becoming laterally compressed, the ninth compressed. Otherwise except sexually as described for the male.

Types.—Holotype male, Olanchito, Honduras, April 24, 1923 (T. H. Hubbell), no. 382; University of Michigan Museum of Zoology. Allotype female, Escuela Agrícola Panamericana, Zamorano, Morazán, July 1, 1948 (T. H. Hubbell), 2,600 feet (garden), no. 13.

Remarks.—This is the second species of this small neotropical genus to be recorded from Central America. *E. nigripes* (Bellardi) was described from Mexico and subsequently recorded from Guatemala by Hine (1917). Carrera (1950) recognizes *Eicherax* as a valid genus; Curran (1934) and Bromley (1934) obviously included it in *Erax*, though later Bromley (1946) apparently admitted its distinctness and listed four species from Brazil, including the widespread *E. nigripes* and *E. macularis* (Wiedemann), the genotype *E. simplex* (Macquart), and *E. ricnotes* (Engel), 1929. The black legs will readily distinguish all but *simplex* from the present species, and *simplex* is described as having only the hind femora blackened above, the description, based on a female, otherwise fitting *flavescens* well, except that no mention is made of the reddish-yellow ground color of the pleura. Since Macquart's type came from Rio Negro, Brazil, it is quite unlikely, in view of these discrepancies, that he had the same species.

Erax barbatus (Fabricius), 1805. Systema antliatorum: 169 (*Dasypogon*). Tela, Dakota farm, May 23, 1923 (Hubbell), no. 608, 5 males, 1 female; Tela, March 14, 1923 (Hubbell), no. 67, 1 male; Tela, March 10, 1923 (Hubbell), no. 47, 3 females; Tela, La Fragua farm, May 7, 1923 (Hubbell), no. 128, 1 male; Tela, Lancetilla, July 28, 1948 (Hubbell); Puerto Castilla, March 3, 1923 (Hubbell), no. 2, 1 male, 1 female, April 26, 1923 (Hubbell), no. 392, 1 male; Escuela Agrícola Panamericana, Zamorano, Morazán, July 1, 1948 (Hubbell), no. 10, roadside, 2,600 feet, 1 male; same, July 8, 1948, no. 39, plain, Yeguare River, 2,550 feet, 1 male, 1 female; same, December 6, 1946 (W. P. Cockerell), 1 male.

Erax loewii Bellardi, 1862. Saggio di ditterologia Messicana, Appendice: 21. Tela, Jilamo

farm, May 28, 1923 (Hubbell), no. 657, 1 male.

Erax stylatus (Fabricius), 1775. Systema entomologiae: 795 (*Asilus*). Tela., Guaimas Dist., May 7, 1923 (Hubbell), no. 491, 1 male, May 10, 1923 (Hubbell), no. 527, 1 male, 1 female, May 5, 1923 (Hubbell), no. 470, 1 female, May 10, 1923 (Hubbell), no. 508, 1 male, May 3, 1923 (Hubbell), no. 452, 1 male, 1 female, and May 8, 1923 (Hubbell), no. 492, 1 female.

Erax poecilolamprus, n. sp.

A member of Hine's *aestuans* group. The legs are wholly black, the femora with a strong metallic blue reflection visible only under certain lights; the male costa is expanded; in the male, the sixth, seventh, and the apex of the fifth tergum are silvery; in the female, the eighth abdominal segment is approximately equal in length to the fifth, sixth, and seventh combined.

Male.—Head black, pale yellowish pollinose on front and face, whitish pollinose on the occiput. Mystax moderately dense: a group of 20–25 black bristles and bristly setae on its upper part and a row of stiff black bristles on the oral margin (sometimes only the lateral ones of this row are black); setae, hairs, and bristles of mystax otherwise yellow. Ocellars black; hairs of vertex mostly black, those of front and occiput mixed black and yellow. Occipital hairs and bristles yellow; a group of three to five stiff bristles with curved tips on each side of the vertex and some adjacent hairs black; an occasional black bristle in the postocular row. Beard rather dense, composed of soft, yellowish, mostly plumose hairs. Antennae black; first and second segments with yellow setulae below, black above; arista 2 to 2½ times as long as the rather short flagellum. Palpi with black and yellow bristles intermixed. Proboscis shining blue-black; some long yellow hairs below.

Thorax black; mesonotum with yellowish pollen, somewhat brassy in certain reflections, anteriorly, which merges into cinereous on the posterior part of the mesonotum, the scutellum, and the pleura; this cinereous pollen, especially on the mesonotum, with brassy to purplish reflections in certain lights; mesonotum with a broad median geminate stripe and to each side of it an oval area, interrupted about medially by the suture; these areas subshining, somewhat bluish in certain reflections, and extending to the posterior declivity of the mesonotum; posterior declivity with three triangular black spots, one above each postalar callus and one medially above the base of the scutellum; in certain lights these are confluent with the middorsal stripe and lateral spots. Some stiff black bristles on the pronotum. Bristles and hairs of mesonotum mostly black; some yellowish hairs on anterior margin, humeri, and above wing bases. Scutellum black-haired on disc, more or less broadly yellow-haired laterally and apically; two to three apical bristles on each side, black, sometimes in part yellow. Pile of prothorax yellow; that of upper parts of pleura generally black, of lower parts generally yellow.

Legs wholly black; femora in certain lights with brilliant metallic blue reflections; coxae cinereous pollinose, legs otherwise subshining. Coxae with yellow hairs and bristles; bristles of legs otherwise at least mostly black; femora with yellowish hairs below, especially long and dense on the front pair, less so on the middle and least so on the hind pair; front and hind tibiae and tarsi with dense, velvety golden pile ventrally; hairs of legs otherwise at least mostly black. Wing venation essentially as in *aestuans*; costa expanded; second submarginal cell with a distinct though short stump-vein basally; membrane brownish, distinctly darker near apex. Halteres yellow.

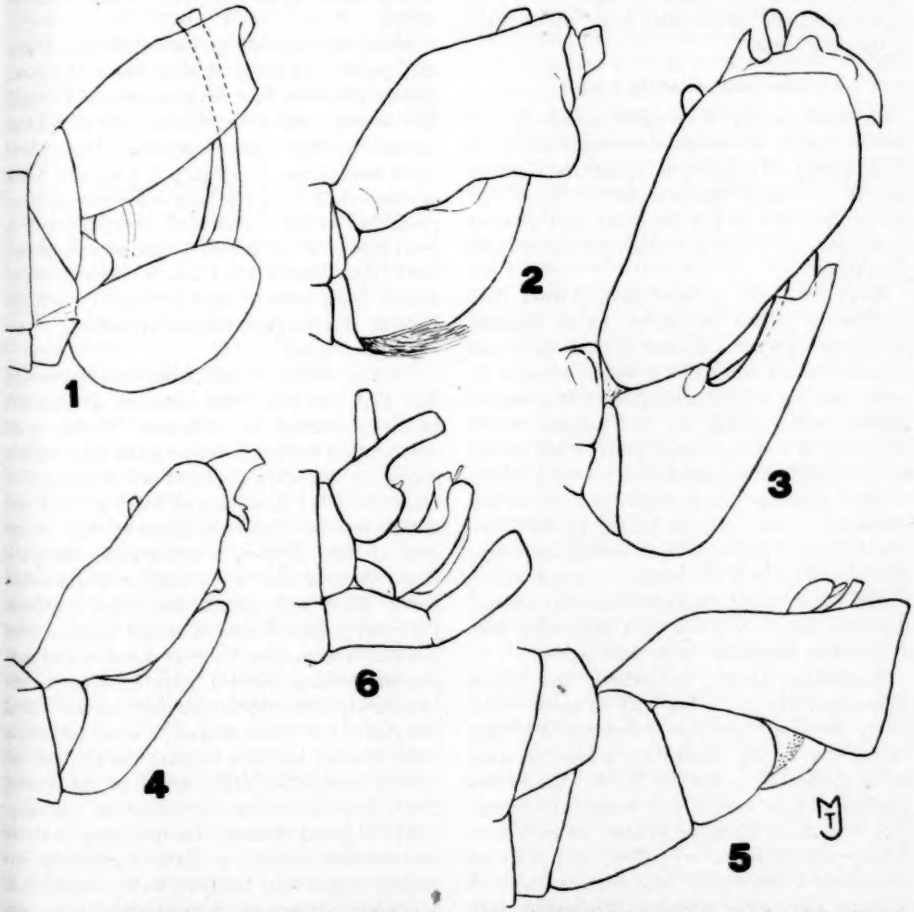
Abdomen black, the apices of terga 2, 3, and 4 brownish; first segment cinereous pollinose; terga 2 to 4 mostly subshining black, the sides broadly cinereous, tergum 4 tending to opaque brownish; tergum 5 brownish black, the sides broadly cinereous and the apex densely silvery; 6 and 7 densely silvery; sterna cinereous, tending to silvery on 6 and 7. Three to four long black (sometimes at least partly yellow) bristles on each side of tergum 1; some short appressed black hairs on the posterior part of tergum 3 and on the discs of 4 and 5; only scattered white hairs on the silvery areas; hairs otherwise yellow. Eighth sternite cinereous, not at all posteriorly directed, but with a dense tuft of posteriorly directed black crinkly hairs at its middle apically. Genitalia shining black with bluish reflections as on the mesonotum (not so strongly metallic as on the femora); hypopygium (Fig. 2) broad from lateral view, truncate and tuberculate apically, with a tuft of black dense inwardly directed hairs on each lower apical margin; genitalia otherwise with scattered hair, mostly black except apically, where it is yellow.

Length, 18–20 mm.

Female.—Wing without costal expansion and with a longer stump at the base of the second submarginal cell; brownish clouding not so apparent as in the male. Abdominal terga 2 to 6 in coloration similar to 2 to 4 in the male; 7 to 9 shining, 8 about equal in length to 5, 6, and 7 combined. Otherwise except sexually as described for the male.

Types.—Holotype, male, Tela, Honduras, May 12, 1923, no. 535 (T. H. Hubbell). Allotype, female, same data but May 3, no. 452. Paratopotypes: 2 males, 2 females, same data as holotype; 1 male, same data as allotype; 2 males, 2 females, same data but May 10, no. 527; 1 male, 1 female, same data but May 8, no. 492; 1 male, same data but May 7, no. 491; 2 females, same data but May 10, no. 512; 1 male, same data but May 5, no. 470; 1 female, same data but May 10, no. 508; 1 female, same data but May 1, no. 414. Paratype, 1 male, Aguan River Valley, Maloa farm, Honduras, April 24, 1923 (Hubbell).

Remarks.—Several neotropical *Erax* of the *aestuans* group have wholly black legs with golden-matted front and hind tibiae and tarsi, and, from their descriptions, seem similar to this



FIGS. 1–6.—Male genitalia, side view; pilosity and bristles omitted except ventral tuft in Fig. 2: 1, *Eicherax flavescens*, n. sp., from holotype; 2, *Erax poecilolamprus*, n. sp., from paratype; 3, *Erax cockerellorum*, n. sp., from holotype; 4, *Erax hubbelli*, n. sp., from holotype; 5, *Proctacanthus caudatus* Hine; 6, *Pachychoeta complicata*, n. sp., from paratype.

species. Two of these are keyed out by Hine (1919, pp. 107, 120), but *loewii* Bellardi(= *dolichogaster* Williston) has only the seventh and the posterior margin of the sixth male terga silvery; *mexicanus* Hine is smaller, has male terga five to seven silvery, and has the seventh male sternum strongly produced apically; both these species have male genitalia different from those of *poecilolamprus*. Of Bromley's Brazilian species *neowillistoni* (=*willistoni* Bromley, *nec* Hine) and *latiforceps* have three submarginal cells; *subchalybeus* has the beard, postgenal hairs, and pruinosity of the face and occiput white, the ensemble giving the insect a light bluish-gray appearance; and *chapadensis* lacks the dilation of the male costa.

Erax cockerellorum, n. sp.

Referable to Hine's *carinatus* group, though with a poorly developed mesonotal mane. A black species with golden to violaceous (depending on the light) thoracic pollen, black legs except the larger part of the tibiae, an expanded male costa, and silvery pollinose sixth and seventh male terga.

Male.—Vestiture of head mostly black, but prominently yellow in places. Facial tubercle prominent; mystax composed of black hairs and bristles except a small tuft of yellow hairs on its upper part and a more prominent tuft of yellow bristles above middle of oral margin. Beard composed of yellow plumose hairs; a few yellow hairs at middle of occiput above; pile and bristles of head otherwise black, including three to five moderately stout occipital bristles on each side above. Color of pollen of head hard to determine but apparently as in the female. Antennae black, wholly black-haired; flagellum lanceolate, about two-fifths length of arista; first segment a little longer than flagellum. Palpi black-haired.

Mesonotum dorsally compressed and typical of the *carinatus* group but with at most a very feebly developed crest; an abundance of bristles behind the suture. Tomentum golden, in some lights violaceous; a median black vitta divided anteriorly by an area of pale tomentum. Scutellum with three marginal bristles on each side, these variably black or yellow, and with an abundance of moderately long pile which is black medially and yellow laterally. Hypopleura with each a tuft of yellow hairs, pile and bristles of pleura otherwise black. Legs mainly black; tibiae mainly bright yellow, apices black, strongly contrasting; front coxa with white and yellow hairs; some yellow hairs at base of front femur below and of middle femur below and laterally; front and hind tibiae with dense short golden pile, middle tibia with longer, more scattered hairs inwardly, that on the hind tibia apically and extending onto the first two tarsal segments golden-brown; bristles and pile otherwise black, with some golden or yellow intermixed; the prevailing appearance of the vestiture of the legs, except when the insect is viewed anteriorly, being black. Wings distinctly brown, the veins black; costa expanded; stump vein at base of second submarginal cell very short. Halteres yellow.

Abdomen with sixth and seventh terga silvery and genital segments shining black; pollinose pattern otherwise hard to distinguish, but sterna, first tergum, and sides of second to fifth terga inclusively apparently cinereous. Pile mixed black and yellow on tergum 1, long and black on sterna 1, 2, 7, and 8, long and white on other pregenital sterna and on sides of terga 2 and 3, short and white on tergum 6, otherwise short and black; most genital pile black; a mane of dense, crinkly black hairs on each process of the ninth sternite. Hypopygium (Fig. 3) robust.

Length, 19 mm.

Female.—Pollen of head mostly golden, except that that just above the antennae and on the facial prominence is cinereous. Mystax with upper tuft of hairs as in the male but with bristles above the oral margin, except one aberrant one, black. Very few pale hairs at bases of front and middle femora. Costa not expanded and stump vein at base of second submarginal cell much longer than the vein connecting it with the radial sector. First and second abdominal segments brownish pollinose; apex of second tergum, third and fourth terga except a large dorsal arrowhead-shaped marking, pointed apically, on each, the moderately interrupted basal and partial lateral margins of the fourth tergum, a small sublateral basal spot on the fifth tergum, the apex of the second, base of the fifth, and all of the second, third, and fourth sterna, cinereous pollinose; eighth segment shining; the remaining parts of the abdomen subshining, black. Eighth segment slightly longer than the fifth, sixth, and seventh combined. Otherwise, except sexually, as described for the male.

Types.—Holotype male, allotype female, Uroca Peak, Honduras, March 9, 1947 (Morelos):

State College of Washington type collection no. 173. The holotype is somewhat "greased," so that part of the pollinose pattern is hard to distinguish, but otherwise it is in good condition.

Remarks.—This species seems to fit best in Hine's *carinatus* group. The mesonotum is compressed as in the more typical members of that group, but the mesonotal crest is very feeble, in fact, hardly discernible. In Hine's key (1919, pp. 107, 131) it runs best to *jubatus*, with which it agrees in having the vestiture of the pronotal declivity entirely black; *jubatus* has a strong crest, however, and differs otherwise in color characters. The male genitalia are of the same general type as those of *jubatus*, though they are more robust and differ considerably in detail. The mesonotum is more strongly compressed than in members of the *barbatus* group and the vestiture of the mesonotal declivity and of the scutellum is longer and denser.

Erax hubbelli, n. sp.

Best referable to Hine's *carinatus* group, although the lack of a mesonotal crest suggests the *barbatus* group. A black species with bicolored tibiae, coppery thoracic pollen, an expanded male costa, and silvery pollinose sixth and seventh abdominal segments in the male.

Male.—Pollen of head yellowish, becoming coppery on front and vertex and on face above facial prominence, more cinereous on facial prominence and along inner occipital orbits. Facial prominence strong. Bristles of mystax black on upper, white on lower half; smaller hairs of face mixed black and white; those above antennae and on ocellar triangle black, long. Beard white, occiput mostly with white vestiture, most of the setae of the postocular fringe and a group of four to six bristles on each side above, and occasionally some of the adjacent hairs, black. Antennae black with black hairs; ratio of first, second, and third antennal segments and of arista 12: 5: 10: 25. Palpi with black hair and bristles. Proboscis shining, a tuft of stout white setae below and some short white hairs apically.

Thorax with coppery pollen which becomes yellowish on lower parts of pleura and cinereous on mesonotal declivity over an indefinite area in front of the scutellum; pollen of scutellum cinereous, yellowish at base; a geminate median vitta and three triangular spots on the mesonotal declivity, one above each wing base and one above the middle line of the scutellum, devoid of pollen; a lateral oval spot on each side of the mesonotal vitta, interrupted at the suture, appearing pollinose only under certain lights. Prothorax with black bristles and with white pile anteriorly and black posteriorly; scutellum with long white crinkly pile and with two to four bristles, usually black, on each side; thorax otherwise chiefly with black hair and bristles. Legs chiefly black; tibiae reddish yellow, distinctly black apically and less distinctly so basally except on the hind pair; bristles of legs black; pile and setulae of coxae yellow, more whitish toward median line of body, those of the underside of the middle and fore femora basally whitish; pile of inner side of fore and hind tibiae and basitarsi dense, short, velvety, golden; vestiture of legs otherwise mainly black, in many places with pale pile intermixed. Wings with a slight tinge of brown; costa inflated; stump vein of second submarginal cell very short.

Abdomen slender; sixth and seventh segments wholly densely silvery pollinose; first segment, sides of terga 2 to 5, and sterna 2 to 5, cinereous pollinose; terga 2 to 5 subshining medially. A few black bristles laterally on each side of tergum 1, terga 4 and 5 with short black hairs, terga 6 and 7 with short silvery hairs; pregenital segments otherwise with rather long crinkly whitish hairs. Eighth sternum transverse, not produced apicad. Eighth segment and genitalia shining black, the hypopygium (Fig. 4) largely bluish-black. Ninth sternum with a dense ventral crest of black, crinkly hairs. Vestiture of genitalia black.

Length, 18 mm.

Types.—Holotype male, Mount Caculatepe, Morazán, Honduras, 4,200–4,500 feet, August 6, 1948 (T. H. Hubbell), no. 203, University of Michigan Museum of Zoology. Paratype, male, Escuela Agrícola Panamericana, Zamorana, Mount Caculatepe, Morazán, Honduras, 4,600–5,200 feet, August 6, 1948 (Hubbell), no. 204.

Remarks.—In Hine's key (1919, pp. 107, 108, 131) this species runs to *bicolor* Bellardi, if traced to the *barbatus* group, where the lack of a mesonotal crest would tend to place it, or to couplet 6 of the *carinatus* group, where the lack of a crest would prevent it from tracing further. *E. bicolor* is quite a differently appearing species, with a more evenly rounded mesonotum, a distinctly grayish pollinose body, a predominantly white pile, and a different hypopygium.

This species, in which the mesonotal crest is

lacking, and the preceding one, in which it is feeble, do not fit well into the *carinatus* group, as Hine defines it. However, among the species which Hine refers to that group, the crest varies considerably in its density, from a very heavy one in such species as *jubatus* Williston and *subcupreus* Schaeffer to a thin one in *cressoni* Hine. In the light of this fact, *cockerellorum* and *hubbelli* do not seem so anomalous. In these two species, as in other members of the group, the facial prominence is very sharply defined, especially above; the third antennal segment is short, lanceolate, and not more than two-fifths the length of the arista; the hairs of the mesonotal declivity and of the scutellum are long and dense; the number of scutellar bristles is small, usually not more than six; the wing of the male has an expanded costa and a very short, sometimes evanescent, stump-vein at the base of the second submarginal cell; and the male genitalia fit a common pattern.

Erax unicolor Bellardi, 1861. Saggio di ditterologia Messicana 2: 37. Zamorano, January 1, 1947 (Cisneros), 1 male, and December 17, 1946, 1 female; Agua Amarilla, December 15, 1946, 1 male.

Erax argyrogaster Macquart, 1846. Dipteres exotiques, Suppl. 1: 84. Negrito, March 27, 1923 (Hubbell), no. 148, 1 male, 2 females.

Erax interruptus (Macquart), 1834. Histoire naturelle des diptères **1:** 310 (*Asilus*). Escuela Agrícola Panamericana, Zamorano, Morazán, July 26, 1948 (Hubbell), 2,600 feet, plain, no. 146, 1 male; same, July 10, 1948 (Hubbell), plains, 2,700 feet, no. 50, 1 male, 2 females; same, July 11, 1948 (Hubbell), flats, Yeguare River, no. 59, 1 female; Galeras, October 19, 1946 (G. Vidales), 1 female.

Erax triton Osten Sacken, 1887. Biologia Centrali-Americana, Diptera, **1:** 200. Zamorano, March 28, 1947 (Adan Oseguero).

Pachychoeta complicata, n. sp.

A black species with predominantly yellow legs, yellowish-brown mesonotal pollen, and lightly infumated wings.

Male.—Head black, the pollen mostly white with a slightly yellow cast, that on the front and vertex distinctly yellow. Bristles and setulae of front, vertex, upper part of occiput, uppermost part of mystax, first two antennal segments, and, in part, of palpi, black; the short hairs near apex of proboscis yellow; vestiture of head otherwise white. Ratio of antennal segments and arista 16: 7: 11: 37; arista distinctly though narrowly flattened apically and terminating in a lanceolate process followed by a short spine. Antenna mostly black, the second segment and the third in part reddish.

Thorax black, the pale-pollinose areas yellowish brown on mesonotum, upper parts of pleura, and base of scutellum, the pollen otherwise whitish with yellow reflections; mesonotum with a median broad blackish-pollinose (reddish brown in some lights) geminate stripe extending from its anterior margin to a point halfway from the suture to the scutellum; an oval presutural and a similar postsutural spot on each side; behind these, a triangular spot on each side and a median prescutellar triangle. Vestiture black on mesonotum, scutellum, and uppermost parts of mesopleura; a few yellow pronotal bristles; vestiture otherwise white.

Legs largely reddish yellow; coxae and trochanters black, pollen as on thoracic pleura; extreme apex of middle and apical third to half of hind femur blackish; hind tibia blackish on approximately the apical half; front and middle tarsi brownish beyond the basitarsi, hind tarsus wholly brownish. Fine, erect hairs of legs mostly pale, the appressed and stiffer ones, however, black; hind femur with both black and yellowish appressed hairs, however; bristles mostly black except on fore femur; front and hind tibiae and tarsi with matted yellow to golden pile below. Halteres yellow. Wings lightly infumated, distinctly darker posteriorly and apically.

Abdomen black; apex of first, sides of second to fifth, and venter of first to fifth segments, whitish pollinose; terga 1 to 5 on disc brownish-black pollinose, this pollen extending, in a paler color, onto disc of tergum 6 at its base and, very narrowly, onto base of tergum 7; apices of terga 2 to 5 lighter brown pollinose; segments 6 and 7 ventrally and, except as noted above, dorsally, silvery pollinose. Long pile on sides and venter, especially toward base of abdomen, and bristles at apices of segments, white; appressed hairs of terga mixed black and white. Genitalia as in Fig. 6; shining, mostly black, the inner parts reddish, blackish to reddish-brown pilose; hypopygium basally on dorsal side with a dense tuft of long black bristles and ventrolaterally on the bulbous part with a group of five to six very long black bristles and several shorter hairs, its terminal digitate process with curly, moderately short,

reddish brown hairs below; ninth sternite prolonged beyond other terminalia, provided with long dense reddish brown hairs laterally and apically, a few black bristles ventrally at the apex, and with mostly black hairs and setulae on its ventral surface.

Length, 17 mm.

Types.—Holotype male, Tela, Guaimas Dist., May 10, 1923 (Hubbell), no. 508; University of Michigan Museum of Zoology. Paratypes: male, same data; male, same data but May 2, 1923, no. 436.

Remarks.—This species agrees in most respects with the description and figures of *Erax annulipes* (Brazil) given by Macquart, so far as the description of a female may fit a male; however, in *annulipes* the wing is figured and described as being uniformly infumated and the thorax and abdomen are said to be gray-pollinose. In view of these discrepancies, I feel reasonably safe in considering the present form distinct.

Proctacanthus caudatus Hine, 1911, Ann. Ent. Soc. Amer. **4:** 159. The series before me seems to be this species, the only discrepancy with Hine's description being that the mystax is partly black; the extent of the black is variable, however, in these five specimens, no two being alike; the black may be limited to *most* of the strong bristles on the oral margin, at one extreme, or, at the other, may involve also most of the setulae above this row. Curran (1934a) does not include *caudatus* in his key; depending on whether the mystax were partly black or wholly yellow, it would run to *dina* Curran, couplet 9, except that the apical lamellae of the ovipositor have only marginal spines, or to *fulviventris* Macquart, from which Hine's key will readily separate it. In the series before me, all thoracic bristles and all hairs and setulae of the mesonotum and scutellum are black; the hairs and setulae of the vertex and, in general, of the upper parts of the pleura, part of the pronotal vestiture, the postocular bristles, and, usually, the tuft of two to four bristles arising among the pale hairs at the sides of the first abdominal segment, are black. The pale pollen of the mesonotum varies from gray to chocolate brown. The male genitalia are as in Fig. 5; the hypopygium is black-haired above, yellow-haired below.

Honduras records.—Tela, May 5, 1923 (T. H. Hubbell), no. 478, 1 male; Tela, May 21, 1923 (Hubbell), no. 601, 1 male; Tela, July 5, 1924, 1 male, 1 female, in copula (U. S. National Museum); Escuela Agrícola Panamericana, Zamorano, July 24, 1948 (Hubbell), 2,250 feet, flat Yeguare River, no. 141, 1 male.

Promachus cinctus Bellardi, 1861. Saggio di ditterologia Messicana **2:** 25. Tela, Guaimas Dist.: May 5, 1923 (T. H. Hubbell), no. 470, 1 female; May 2, 1923 (Hubbell), no. 442, 1 female; May 10, 1923 (Hubbell), no. 529, 1 female; May 9, 1923 (Hubbell), no. 505, 1 male; May 8, 1923 (Hubbell), no. 492, 1 male; May 10, 1923 (Hubbell), no. 508, 1 female; May 12, 1923 (Hubbell), no. 535, 1 female; May 9, 1923 (Hubbell), no. 497, 1 male. Progresso, May 1, 1923 (Hubbell), no. 497, 1 male.

Promachus forfex Osten Sacken, 1887. Biologia Centrali-Americana, Diptera; **1:** 194. Tela, Guaimas Dist., May 10, 1923 (T. H. Hubbell), no. 508, 1 male.

Promachina trapezoidalis (Bellardi), 1861. Saggio di Ditterologia Messicana **2:** 28 (*Promachus*). Tela, Guaimas Dist.: May 3, 1923 (T. H. Hubbell), no. 452, 1 female; May 2, 1923 (Hubbell), no. 440, 1 male, 2 females; May 9, 1923 (Hubbell), no. 497, 2 females; May 12, 1923 (Hubbell), no. 535, 1 female; May 2, 1923 (Hubbell), no. 442, 1 male; May 10, 1923 (Hubbell), no. 527, 1 female. Progreso, May 1, 1923 (Hubbell), no. 544, Choluteca River bridge, Tegucigalpa-Danli Road, 1,950 feet, El Paraíso Dist., July 25, 1948 (Hubbell), no. 142, 1 male.

Mallophora freycineti Macquart, 1839. Diptères exotiques **1**(2): 85. Zamorano, March 28, 1947 (Salazar), 1 male.

Mallophora sp. This species traces to *abana* Curran in Curran's key (1934b), but it does not fit the description of that species. It is probably new, but I do not feel secure in describing it as such. Tela, Guaimas Dist., May 3, 1923 (T. H. Hubbell), no. 452, 1 male.

Atomosia hondurana, n. sp.

Close to *rufipes* Macquart, but with about the apical half of the hind tibia, a preapical band on the hind femur, at least the last two tarsomeres of the hind tarsus, and the postalar callus black.

Male.—Head black, entirely covered with pollen which is yellowish on the vertex and upper occiput, otherwise silvery; mystax, beard, and pile of palpi and proboscis white; that of vertex and antennae yellow, except that it becomes black at the apex of the first and second antennal segments; ocellar bristles one pair, yellow; first antennal segment with an outstanding yellow

bristle. Antennae structurally as in *rufipes*, elongated, first segment about twice second in length, third with the short dorsal spine a little beyond its middle; black, second segment reddish. Palpi black; proboscis shining black.

Thorax including postalar callus wholly black; mesonotum with appressed brassy tomentum and with semierect hairs on middle line and in dorsocentral rows; mesonotum from posterior view appearing to have two longitudinal tomentose vittae. Scutellum with two pairs of marginal bristles, the outer ones small and sometimes difficult to distinguish. Pleura silvery-pollinose, hairs mostly white, those on upper part more yellowish. Coxae black, silvery pollinose and pilose; front and middle femora and tibiae wholly yellow with white to yellow hairs and bristles; hind femur with a broad preapical black annulus, otherwise yellow; hind tibia black on the apical half or sometimes more, otherwise yellow; pile of legs mostly white, bristles white to yellow; a fringe of white hairs ventrally on the hind tibia and femur, denser on the former. Front and middle tarsi each with apical tarsomere black with black hairs, otherwise yellow with yellow hairs and bristles; hind tarsus with usually last four tarsomeres wholly black, at least above, the hairs and bristles mixed black and yellow. Wings hyaline, veins brown; first posterior cell usually closed in the margin.

Abdomen black, shining bluish in certain lights; terga 2 to 5 very narrowly margined posteriorly with silvery pollen, the margins a little broader laterally; brassy yellow tomentum dorsally on the segments, white pile laterally and ventrally. Hypopygium black; genitalia ventrally yellow, yellow-haired.

Length, 8 mm.

Female.—Very much like the male, but on the average slightly larger and a little more robust.

Types.—Holotype male, Escuela Agrícola Panamericana, Zamorano, 2,600 feet, at light, July 14, 1948 (T. H. Hubbell); University of Michigan Museum of Zoology. Allotype female, same data but July 11, 1948, on gardenia (Hubbell), no. 58. Paratopotypes: 5 females, same data as allotype; 2 males, 3 females, July 4, 1948 (Hubbell), on gardenia, no. 25; 3 males, 5 females, July 9, 1948 (Hubbell), tall weeds, no. 45; 1 male, July 2, 1948 (Hubbell), 2,550 feet, flats, Yeguare River, no. 18; 1 male, Aug. 16, 1948 (Hubbell), on citrus, no. 225; 1 female, July 1, 1948 (Hubbell), roadside, no. 10; 1 female, July 29, 1948 (Hubbell), thicket, no. 162.

Remarks.—There is some variation in the color of the legs. The hind tarsus is usually as described, though the black may exceptionally be limited to the last two or three segments. The black on the hind tibia and femur may be more extensive, so that the segments may be more than half black. The black coloration is usually quite distinct and may have a metallic blue sheen.

In Curran's (1930) key this species traces to *tenuis* Curran from Brazil, from which it may readily be distinguished by the wholly pollinose vertex, occiput, and pleura; in Hermann's (1912) key it runs to *glabrata* (Say), but in that species the first antennal segment is shorter and the pattern of leg coloration is different. The brief original description of *anonyma* Williston agrees with my specimens, so far as it goes, but according to Curran's key *anonyma* has six or more ocellar bristles. The closest relationship, so far as I can determine, is with *rufipes* Macquart and species of that complex; this may be a subspecies of *rufipes*.

Cerotainia minima Curran, 1930. Amer. Mus. Nov., no. 425: 12. Escuela Agrícola Panamericana, Zamorano, Morazán: July 9, 1948 (T. H. Hubbell), tall weeds, no. 45, 3 males, 3 females; July 19, 1948 (Hubbell), weed thicket, no. 106, 2 males, 8 females; July 22, 1948 (Hubbell), herbage and brush, no. 125, 1 male; July 6, 1948 (Hubbell), on rose, 2 females; July 15, 1948 (Hubbell), on citrus, no. 76, 1 female; July 1, 1948 (Hubbell), roadside, no. 10, 1 female. Zamorano, October 10, 1946, (Cisneros), 1 female; October 1946 (A. Carr), 1 female.

Cerotainia ornatipes, n. sp.

A black species with robust females, more slender males; the thorax thickly and entirely black-haired; the tarsi, except the apical segment of each, yellow, those of the male, especially the fore and middle pair, with appressed silvery hairs apically; the wing strongly clouded on the basal half.

Male.—Head black, covered with an ochraceous pollen anteriorly and on the vertex and a silvery pollen on the occiput; mystax white with a few scattered black bristles; pile of head otherwise mostly white, the beard silvery; ocellar bristles two, yellow, in addition a few yellowish hairs on the ocellar triangle; occipital bristles

black, not rising from tubercles. Antennae elongated, structurally much as in *dasythrix*; first segment eight to nine times as long as wide, about four times length of second; third segment missing in both males of the type series, presumably much as in the female; antennae black, black-haired, the first segment with an outstanding black, bristle below, the second with one below and one above. Proboscis black, black- and white-haired.

Thorax entirely black; mesonotum and scutellum with distinct bluish reflections when viewed under magnification; prothorax except pronotal collar, humeri, pleura, and metathorax pollinose, the pollen mostly ochraceous; all thoracic bristles and pile black, that of the mesonotum erect and dense; scutellum with an apical fringe of hairlike bristles which are distinctly longer than the pile of the disc. Mesopleura only moderately convex, not unusually swollen. Coxae black, ochraceous pollinose; femora black with bluish reflections as on the mesonotum; tibiae yellow with considerable infuscation, the hind one with a weak bluish reflection; tarsi bright yellow except apical tarsomere of each, which is black. Pile and bristles of fore and middle tarsi yellow, the pile becoming silvery and appressed dorsally on the last two tarsomeres; bristles of hind tarsus black, its pile yellow ventrally, black dorsally on the basal tarsomeres, with some yellow pile on the third and some yellow and silvery on the last two tarsomeres; pile and bristles of the coxae, femora, and tibiae wholly black. Wing distinctly brown at base and along costal margin, gradually becoming subhyaline apically and posteriorly. Halteres infuscated.

Abdomen elongated, tapering almost to a point; terga black with reflections as on the mesonotum, sterna densely ochraceous pollinose; vestiture black, with quite a few rather inconspicuous yellow appressed hairs on the fifth and sixth terga. Genitalia yellow, yellow-haired.

Length, 6–6.5 mm.

Female.—More robust than the male, especially the abdomen. Ratio of antennal segments 55: 15: 70. Pile of tarsi black dorsally, yellow ventrally; no silvery tarsal pile as in the male. Abdomen oval.

Types.— Holotype, male, Zamorano, January 14, 1947 (W. P. Cockerell); State College of Washington Type Collection no. 174. Allotype female, Zamorano, January 29, 1947. Paratopotypes: 2 females, Zamorano, December 7, 1946 (W. P. Cockerell) and December 25, 1946 (T. D. A. Cockerell); 1 male, January 29, 1947.

Remarks.—The relationship to *C. dasythrix* Hermann seems to be very close. It traces there in both Curran's (1930) and Hermann's (1912) keys, and the antennal structure is precisely as illustrated by Hermann. According to the description of *dasythrix*, however, in that species the mystax and the pale vestiture of the head are yellow, there is a transverse band of golden hair behind the humeri, the tarsi are (wholly?) reddish brown and only the middle pair has silvery hair dorsally, and the body has a dark green (thorax) or brownish green to violet (abdomen, reflection.

Taracticus argentifacies, n. sp.

A black species with predominantly black legs, predominantly silvery pollinose head and thorax, and small spinelike setulae forming most of the mesonotal vestiture.

Male.—Head black, almost wholly covered with silvery pollen which is densest on the face and lower part of the occiput; the ocellar triangle at most in part subshining posteriorly. Mystax and beard white; bristles of occipital fringe yellow; ocellar triangle with one or two (one on one side, two on the other, in the type) pairs of small yellow bristles. Palpi and proboscis shining black with white hairs, the short ones at the apex of the proboscis yellow. Antennae black; the dorsal spine of the third segment set at about three-fifths the length of the segment.

Thorax wholly black. Prothorax mostly silvery pollinose with white hairs and yellow pronotal bristles. Mesonotum largely lightly silvery to cinereous tomentose; posterior part of humerus, a rectangular presutural lateral area, a small spot above the wing base, the postalar callus, and a preapical rim of the scutellum, shining; a pair of yellowish-pollinose stripes on the mesonotum, arising behind the suture and bowed strongly outward toward the humeri, contrasting with the rest of the mesonotal pollen. (The exact extent of the mesonotal and scutellar pollen is a little hard to determine because parts of these areas have been smeared with adhesive.) Mesonotum provided with numerous yellow spinelike setulae or short stout bristles and with hardly any softer hairs; hairs and bristles of pleura white. Scutellum with one pair of small yellow bristles. Legs mainly black, shining or subshining except the coxae; knees and bases of the hind femur,

tibia, and basitarsus yellow; pile and bristles of legs yellow. Wing hyaline, the veins brown; fourth posterior cell very little narrowed. Halteres yellow.

Abdomen mostly black, seventh and genital segments yellow; terga with numerous setulose punctures, the setulae yellow to golden, laterally becoming pale yellow to white toward the base of the abdomen. Terga 1 to 4 each with a transverse rectangular silvery-pollinose spot apically on each side, these spots confined to about the lateral fourth of the segments; a very small round spot, removed from both apical and lateral margins, representing a remnant of such a spot on tergum 5; sterna cinereous-pollinose with scattered, fine white hairs. Genitalia yellow, yellow-haired.

Length, 7 mm.

Type.—Holotype male, Dept. Morazán, ridge between La Montañita and C. Uyuca, 5± km southwest of Suyapa, 5,200-5,400 feet, August 5, 1948 (T. H. Hubbell), fir woods; Museum of Zoology, University of Michigan.

Remarks.—In Pritchard's (1938) key this species runs to *vitripennis* (Bellardi) from which it may readily be distinguished by the ochraceous face, the mostly shining mesonotum, and other characters. If the small pollinose area on the fifth tergum is taken into consideration in Pritchard's key, this species will run to *nigripes* Williston, from which the bare ocellar triangle, the ochraceous thoracic pollen, the silvery lateral bar of the sixth abdominal segment, and other characters will distinguish it. The relationship to *nigripes* seems to be very close.

Andrenosoma (*Pilica*) *erythrogaster* (Wiedemann), 1828. Aussereuropäische Zweiflügelige Insekten **1:** 523 (*Laphria*). Tela, Guaimas Dist., May 5, 1923 (T. H. Hubbell), no. 478, 1 male, no. 470, 1 female; same, May 3, 1923 (Hubbell), no. 452. 1 female.

Laphria marginalis Williston, 1901. Biologia Centrali-Americana, Diptera, **1:** 318. Negrito, March 19, 1923 (T. H. Hubbell), no. 128, 1 female.

Lampria (*?mexicana* Macquart), 1847. Dipteres exotiques, Suppl. 2: 37. Tela, May 27, 1923 (T. H. Hubbell), Jilamo farm, no. 645, 1 female.

Aphestia nigra Bigot, 1878. Ann. Soc. Ent. France (5) **8:** 235. Tela, Guaimas Dist., May 3, 1923 (T. H. Hubbell), no. 452, and May 5, 1923 (Hubbell), no. 473, 1 male, 1 female.

Psilicurus caudatus Williston, 1901. Biologia Centrali-Americana, Diptera, **1:** 308. Tela, Guaimas Dist., May 1, 1923 (T. H. Hubbell), no. 414, 1 female, May 3, 1923 (Hubbell), no. 452, 1 male, and May 10, 1923 (Hubbell), no. 527, 1 male.

Stichopogon trifasciatus (Say), 1823. Journ. Acad. Nat. Sci. Philadelphia **3:** 51 (*Dasypogon*). Zamorano, December 6, 1946 (W. P. Cockerell), 1 male; Progreso, March 28, 1923 (Hubbell), no. 150, 1 male; Tela, March 10, 1923 (Hubbell), no. 47, and May 21, 1923 (Hubbell), no. 596, 2 females.

Holcocephala deltoidea (Bellardi), 1861. Saggio di ditterologia Messicana **2:** 85 (*Discocephala*). Zamorano, January 15, 1947 (Dorothy Wiley), 1 male.

Holcocephala oculata (Fabricius), 1805. Systema antiliatarum: 151 (*Dioctria*). Tela, April 28, 1923 (T. H. Hubbell), no. 406, 1 male; Tela, Guaimas Dist., March 17, 1923 (Hubbell), no. 115, 1 male; Río Claura, April 13, 1923 (Hubbell), no. 264, 1 female.

Holcocephala affinis (Bellardi), 1861. Saggio di ditterologia Messicana **2:** 86 (*Discocephala*). Río Paulaya, Barranco, April 16, 1923 (Hubbell), no. 290, 1 female. The above specimen agrees with the characterization given by Pritchard (1938), who stated that the species had not been recognized again since its original description.

Diogmites ialapensis (Bellardi), 1861. Saggio di ditterologia Messicana **2:** 65 (*Saropogon*). Tela, Dakota farm, May 26, 1923 (T. H. Hubbell), no. 639, 1 male; Zamorano, Escuela Agrícola Panamericana, 2600′, July 1, 1948 (Hubbell), roadside, no. 10, and 2,550 feet, July 2, 1948 (Hubbell), flats, Yeguare River, no. 18, 2 females.

Lissoteles hermanni Bezzi, 1910. Boll. Lab. Zool. Generale e Agraria, Portici, **4:** 178. Bezzi described this species from a single female. My specimen fits his description very well except for the thoracic pattern, which may very well be subject to variation. Bezzi described the mesonotum as gray-tomentose with a pair of not very distinct brown longitudinal stripes which diverge anteriorly. My specimen has two crescentric brown spots behind the humeri; these may well be the diverging anterior arms of these stripes, which otherwise do not seem to appear. There is a small brown bar about half way between each humerus and the suture and removed some distance from the notopleural suture; just behind the suture and above the wing base there is a

round subshining black spot bordered with brown pollen below. Bezzi described the scutellum as having no macrochaetae; it does, however, have numerous long erect hairs, especially toward its apex, some of which are almost bristlelike. Bezzi is uncertain about the abdominal pollen since in his specimen the abdomen is not in a good state of preservation ("greased"?). In my specimen the abdominal terga, especially 2 to 6 inclusively, are cinereous pollinose at the bases and sides, briefly so also apically, but with gray pollen, in places with somewhat of a yellow tinge, in the middle.

Honduras record.—Puerto Castilla, May 3, 1923 (T. H. Hubbell), no. 2, 1 female.

LITERATURE CITED

BROMLEY, S. W. *Asilidae*, in Curran, C. H., *The Diptera of Kartabo, Bartica District, British Guiana*. Bull. Amer. Mus. Nat. Hist. **66** (3): 327–360. 1934.

———. *The robber flies of Brazil*. Livro de homenagem a R. R. d'Almeida, no. 8: 103–120. 1946.

CARRERA, MESSIAS. *Synoptical keys for the genera of Brazilian "Asilidae" (Diptera)*. Rev. Brasil. Biol. **10** (1): 99–111. 1950.

CURRAN, C. H. *New American Asilidae (Diptera)*. Amer. Mus. Nov., no. 425: 1–21. 1930.

———. *The families and genera of North American Diptera*, 512 pp. New York, 1934.

HERMANN, F. *Beiträge zur Kenntnis der südamerikanischer Dipterenfauna aus Grund der Sammelergebnisse eines Reise in Chile, Peru, und Bolivia. Asilidae*. Nova Acta Abh. Kais. Leop.-Carol. Deutsch. Akad. Naturf. **96**: 1–275. 1912.

HINE, JAMES S. *Costa Rican Diptera collected by Philip P. Calvert, Ph.D., 1909–1910. Paper 2: Tabanidae and Asilidae*. Trans. Amer. Ent. Soc. **43**: 291–299. 1917.

———. *Robberflies of the genus* Erax. Ann. Ent. Soc. Amer. **12**: 103–157. 1919.

PRITCHARD, A. EARL. *Revision of the robberfly genus* Taracticus *Loew with descriptions of three new species (Diptera, Asilidae)*. Journ. New York Ent. Soc. **46**: 179–190. 1938.

ZOOLOGY.—*Two new species of* Eulimnadia *from Maryland and Virginia (Crustacea: Conchostraca)*. N. T. MATTOX, University of Southern California.[1] (Communicated by Fenner A. Chace, Jr.)

During the course of studies of the conchostracan phyllopods in the collections of the U. S. National Museum two new members of the genus *Eulimnadia* were found. These animals were represented in 13 collections from temporary pools found in 3 different localities.

Eulimnadia ventricosa, n. sp.

Description.—Male: With characters of the genus (Packard, 1883, and Daday, 1926). The bivalve shell is amber colored, transparent, and elongately oval (Fig. 1, *a*). The dorsal margin is slightly rounded with the highest elevation (umbo) approximately two-fifths the length from the anterior margin. The ventral margin of the shell is greatly rounded, with the posterior end more truncate than the anterior. The length of the shell averages 8.5 mm with an average height of 5.2 mm. The lines of growth vary in number from 8 to 12, with the outer ones very closely spaced.

The head possesses the typical frontal organ (Fig. 1, *c*). The front is straight dorsally, but prominently extended ventrally forming a conspicuous rostrum. The scape of the second antennae extends beyond the tip of the rostrum. Each flagellum of the second antennae is variously spined and has nine segments, the posterior one being longer than the anterior. The first antennae are longer than in the female, extending to the distal end of the third segment of the flagellum of the second antennae. The first antennae possess 9 or 10 dorsal sensory papillae.

The body bears 18 pairs of swimming legs. The first and second pair are modified into the claw-like gnathopods typical of the genus. The two segments of the sixth endite of the first pair of gnathopods are of the same length (Fig. 1, *e*). The terminal segment of the sixth endite of the second gnathopod is approximately twice the length of the proximal segment and is much longer than that of the first gnathopod (Fig. 1, *f*). The posterior 10 to 12 body segments bear middorsal spines.

The telson is elongate, the ventral margin much shortened extending only one-third the distance of the dorsal margin (Fig. 1, *g*). The dorsal ridges of the telson are variously spined with 14 to 16 pairs of spines. The terminal telson

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claws are elongate and tapered, extending posteriorly to a distance equal to the length of the dorsal margin. The dorsal forked filament arises between the third and fourth pair of telson spines.

Female: The female shell is much more rounded, ventricose, in outline (Fig. 1, *b*). Both the dorsal and ventral margins are very rounded with the greatest height near the center. The length of the shell in mature females varies from 7.7 to 10.7 mm, and the height varies from 5.3 to 6.8 mm. The average size of those measured is 8.9 mm by 6.1 mm. The number of growth lines averages 10, with a variation of 8 to 12.

The front of the head is much less concave than in the male with the rostrum less pronounced (Fig. 1, *d*). The second antennae are similar to those of the male. The first antennae are much reduced, not extending beyond the distal end of the scape of the second antennae.

The swimming legs, 18 pairs, are unspecialized, being of the general, swimming type characteristic of the genus.

The telson is similar to that of the male with 14 to 19 pair of dorsal spines, 15 pairs is the average number.

Type locality.—Bear Island, Potomac River, Montgomery County, Md.

Types.—Holotype, male, U.S.N.M. no. 93439; paratypes, both sexes, U.S.N.M. no. 93440, and in writer's collection.

Remarks.—*Eulimnadia ventricosa* more closely resembles *E. stoningtonensis* Berry than any other North American species of the genus. *E. ventricosa* differs from *stoningtonensis* in the longer first antennae of the male; the greater number of telson spines, 14 being the maximum number in *stoningtonensis*; the origin of the forked filament of the telson between the third and fourth spines instead of between the fifth and sixth as in *stoningtonensis*; the more pronounced rostrum; a shell length-height ratio of 1.6 to 1 as against a 1.4 to 1 ratio for *stoningtonensis*; up to 12 growth lines in contrast to 10 for *stoningtonensis*; and a maximum size up to 10.7 mm, with 8.5 mm the longest shell length for *stoningtonensis*. Compared to other North American species *E. ventricosa* is larger, more ventricose, and has more lines of growth than any other member of the genus.

Eulimnadia ventricosa is represented in nine collections. This species was taken in seven collections from Bear Island, Md., by Robert S. Bray during July and September, 1941. Notes on the environment for these collections indicate that they were taken in small temporary pools with a recorded temperature variation of 71 to 88°F. and a pH variation of 6.4 to 6.7. In these collections there were 90 females and 9 males indicating a greater ratio of females than males as seems to be the case for other species of the genus.

The species is also represented in a collection of 16 females and 2 males taken at Lilypons, Frederick County, Md., by O. L. Meehean on July 12, 1937. Also, there was one female in a collection of *Cyzicus mexicanus* made by Eric Tuttle in a temporary pool between Chain Bridge and Georgetown, D. C., on July 18, 1950.

Eulimnadia francesae, n. sp.

Description.—Male: The bivalve shell (Fig. 1, *h*) is pale yellow, transparent, and very much elongate. The dorsal margin is nearly straight with only a slight elevation near the center of the shell. The ventral margin is regularly rounded. The shell length varies in mature males from 4.3 mm, with a height of 2.5 mm, to 4.5 by 2.7 mm. There are 1 or 2 lines of growth, with 2 the common number, located near the outer margin.

The head possesses the typical, dorsal pyriform frontal organ (Fig. 1, *j*). The front is very straight, only slightly concave. The scape of the second antennae is short, extending only slightly beyond the tip of the rostrum. The flagella of the second antennae are variously spined, 9 segmented, and are relatively short. The first antennae with 10 to 12 dorsal papillae extends to the distal end of the fifth segment of the second antennae flagella.

The body bears 18 pairs of swimming legs. The first and second pairs are modified gnathopods. The sixth endite of the first gnathopod is shorter than the length of the "claw" portion (Fig. 1, *l*). The two segments of the sixth endite of the second gnathopod are of equal length. (Fig. 1, *m*).

The telson is truncate in general form (Fig. 1, *n*). The dorsal ridges are armed with 9 to 11 spines. The dorsal forked filament arises between the second and third pairs of spines. The terminal telson claws are elongated; they extend posteriorly less than the length of the dorsal telson margin.

Female: The shell is elongately oval with the dorsal margin slightly elevated (Fig. 1, *i*). The ventral margin is regularly and prominently rounded with the greatest height near the center of the shell. The number of growth lines on

mature individuals varies from 2 to 4 with the greater number possessing 3 lines.

The head of the female is very similar in form to that of the male (Fig. 1, *k*). The front is only slightly concave and the dorsal surface is very convex with the occipital notch very conspicuous.

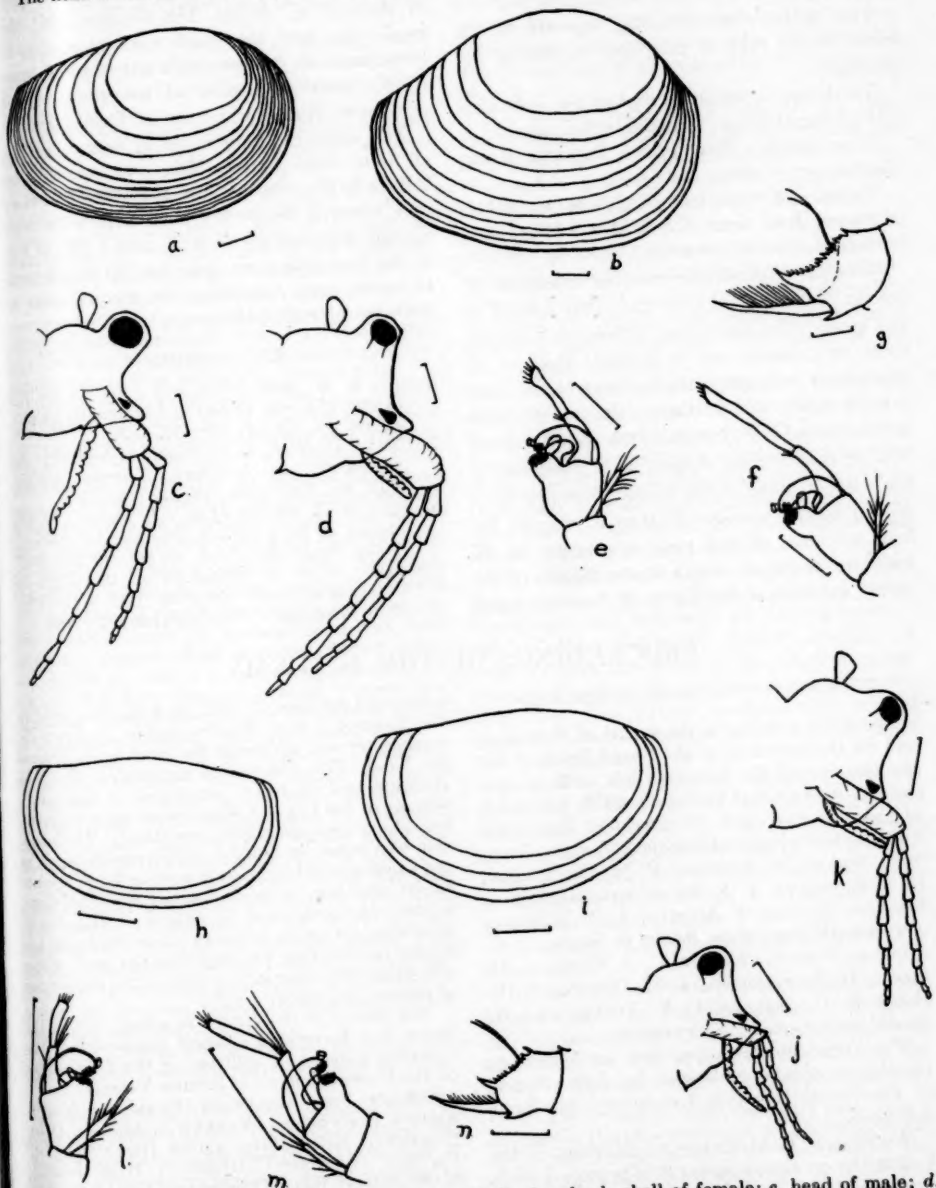

FIG. 1.—*a–g*, *Eulimnadia ventricosa*, n. sp.: *a*, Shell of male; *b*, shell of female; *c*, head of male; *d*, head of female; *e*, first gnathopod of male; *f*, second gnathopod of male; *g*, telson. *h–n*, *Eulimnadia francesae*, n. sp.: *h*, Shell of male; *i*, shell of female; *j*, head of male; *k*, head of female; *l*, first gnathopod of male; *m*, second gnathopod of male; *n*, telson. Scales: *a*, *b*, *h*, *i* equal 1 mm; all others 0.5 mm.

The second antennae have a longer scape than the male. The flagella of the second antennae are 9 segmented and are of equal length as in the male.

The 18 pairs of swimming legs are of the characteristic type of phyllopod swimming appendages.

The telson is similar to that of the male with 9 to 11 dorsal spines; 10 is the typical number.

Type locality.—Bear Island, Potomac River, Montgomery County, Md.

Types.—Holotype, male, U.S.N.M. no. 93446, paratypes, both sexes, U.S.N.M. no. 93447, and in the collection of the writer.

Remarks.—*Eulimnadia francesae* resembles *E. diversa* Mattox more than the other species in the genus. The distinctive differences between these two species are as follows: Shell of *E. francesae* is more elongate; the front of the head is more concave in *E. diversa*; the frontal organ is more dorsal in *E. francesae*; the occipital notch is more conspicuous, deeper, in *E. francesae*, in the relative length of the second antennae those of *E. francesae* are shorter than *E. diversa*; the first antennae of the male are longer in *E. francesae*; the equal length of the flagella of the second antennae is distinctive; *E. francesae* has a normal number of 10 telson spines while *E. diversa* has an average of 12; and the ventral telson claws of *E. francesae* are not as elongate as those of *E. diversa*. The elongate shell, the small size, and the small number of growth lines, make *E. francesae* different from all other North American species of the genus except *E. alineata* Mattox which has no lines of growth.

This species is represented in four collections all from Bear Island, Md., and collected by Robert S. Bray during July 1941. These animals were found in temporary pools with a recorded average temperature of 80°F. and a pH of 6.2. In the four collections there are 102 females and 17 males, again indicating the unequal ratio of the sexes typical of the genus.

REFERENCES

BERRY, E. W. *Description and notes on the life history of a new species of* Eulimnadia. Amer. Journ. Sci. (5) **11**: 429–433. 1926.

DADAY DE DEES, E. *Monographie systematique des phyllopodes conchostraces*, Triseme Partie. Ann. Sci. Nat. Zool. (10) **11**: 1–81. 1926.

MATTOX, N. T. *Studies of the life history of a new species of fairy shrimp*, Eulimnadia diversa. Trans. Amer. Micr. Soc. (2) **56**: 249–255. 1937.

PACKARD, A. S. *A monograph on the phyllopod Crustacea of North America*. 12th Ann. Rep. U. S. Geol. Surv. Terr., Hayden, **1**: 1883.

PROCEEDINGS OF THE ACADEMY

457TH MEETING OF BOARD OF MANAGERS

The 457th meeting of the Board of Managers, held for the first time in the Board Room of the new quarters of the Cosmos Club, 2121 Massachusetts Avenue, on October 13, 1952, was called to order at 8:07 p.m. by President RAMBERG, with the following in attendance: WALTER RAMBERG, FRANK M. SETZLER, F. M. DEFANDORF, H. S. RAPPLEYE, J. A. STEVENSON, HARALD A. REHDER, WILLIAM F. FOSHAG, A. T. MCPHERSON, SARA E. BRANHAM, ROGER G. BATES, A. G. MCNISH, JOHN K. TAYLOR, C. A. BETTS, A. H. SCOTT, L. A. SPINDLER, A. M. GRIFFIN, N. R. ELLIS, E. H. WALKER, L. E. YOCUM, and, by special invitation, F. N. FRENKIEL.

The President announced that the November meeting would be addressed by John Hagen, of the Naval Research Laboratory, on *Radio astronomy*.

ARCHIBALD T. MCPHERSON, chairman of the Committee on Encouragement of Science Talent, presented the following report:

Junior Academy.—The organization of the Washington Junior Academy of Sciences was consummated on June 13, 1952, at a meeting held in the Cosmos Club. Watson Davis, director of Science Service, addressed the meeting on *Science for Youth*. The Committee designated about 85 students and 40 recent graduates of secondary schools in the Greater Washington area as members and alumni members, respectively. The selection was based on tangible achievements such as the winning of recognition in science fairs, science talent searches, or related activities. The Committee also designated 57 fellows of the Junior Academy, including teachers whose students had shown outstanding accomplishments and others who have been especially active in the promotion of science education.

The affairs of the Junior Academy are in the hands of a Governing Council comprised of the following persons in addition to the Committee on the Encouragement of Science Talent:

Officers: FRED SCHINDLER (President), Northwestern High School; VERNON J. MICHEL (Vice President), Kelly Miller Junior High; STANLEY PLATNIK (Treasurer), Roosevelt High School; MARY JEANNE KREEK (Secretary), Woodrow Wilson High School.

Alumni Representatives: CAROL COLSON, Eastern High School; LEE KIMBELL, McKinley High School–American University.

Fellow Representatives: MARGARET E. PATTERSON, Science Clubs of America; PERCY J. RAYFORD, head, Department of Science, Division 2; KEITH C. JOHNSON, head, Department of Science, Division 1.

Membership Representatives: DANIEL MIX, Macfarland Junior High School; SIEGFRIED T. BALZER, Gonzaga High School; DAVID W. RAY, Dunbar High School.

Science Service has kindly provided a meeting place for the Governing Council as well as office facilities.

The first meeting of the Junior Academy for the current season was held at the George Washington University on September 19 through the courtesy of Dr. Yocum, dean of the Graduate School. HOWARD OWENS gave an illustrated lecture on *Selection of a Science Project*, after which the meeting divided into eight discussion groups each led by an outstanding scientist of the Washington area who gave further advice and guidance regarding the selection of projects in specific fields.

Cooperation with Engineers.—The D. C. Council of Engineering and Architectural Societies has a Committee on Education which has been assigned duties parallel to those of two Academy Committees—the Committee on Science Education headed by DR. BRODE, and the present Committee on Encouragement of Science Talent. DR. W. T. READ, chairman of the Education Committee of the Council, is also a member of the Academy, Committee on Encouragement of Science Talent and provides liaison between the activities of the two organizations. An understanding has been arrived at whereby the Committee of the Council will direct its efforts at arranging speakers for school assemblies and conferences whereas the Academy Committee will take the lead in affairs of the Junior Academy and the Science Fair.

A subcommittee of the Academy Committee is being set up under the chairmanship of DR. A. H. SCOTT to arrange for scientists to speak in schools along with engineers and to cooperate with a parallel subcommittee of the Engineers under the chairmanship of MR. MCCARTHA.

Science Fair.—An estimate of $1,000 has been made for the cost of the Science Fair to be held next spring. Letters have gone out to all the societies affiliated with the Academy asking them for contributions, and the President of the Academy has been asked personally to present the matter to the vice presidents representing the respective societies.

The D. C. Council, likewise, is asking for substantial contributions from its affiliated societies.

A discussion of this report brought out the following additional information: Eligibility for charter membership was based on (1) selection of members by science teachers whose activity in connection with the Science Fair and Science Talent Search projects was exceptionally good, (2) the selection of teachers to be designated as fellows based on the performance of their students judged on the same basis; certain other fellows were designated on the basis of their interest as evidenced by activity in this connection, (3) the selection as alumni members of a few graduates on the basis of their accomplishments as evidenced from these projects and the recommendation in addition of those teachers designated as fellows.

The annual membership dues are $1. The Junior Academy is solvent. So far nothing has been spent out of the $100 provided by the Washington Academy for initial organizational expenses of the Junior Academy. The academies of Maryland and Virginia have no objection to students in nearby schools becoming members of the Washington Junior Academy of Sciences. Treasurer RAPPLEYE, who is ex-officio custodian of funds, will handle and report on the Junior Academy funds separately from those of the Washington Academy.

For the Committee on Science Education, A. T. McPherson reported that its chairman, W. R. BRODE, had discussed with Judge Laws the matter of appointing a scientist as a member of the District of Columbia Board of Education. It appears that all appointments to the Board have been completed so that recommendations would be out of order at this time.

In accordance with action by the Board at its last meeting, ballots relative to changes in the constitution and bylaws to provide for sponsorship of the Washington Junior Academy of Sciences were forwarded to the Academy membership. Copies of the proposed constitution and bylaws for the Junior Academy and a brief summary of actions by the Board on this connection were attached.

Deaths of the following members were reported: E. C. AUCHTER, on July 8, 1952; IDA A. BENGSTON, on August 15, 1952; R. A. KELSER, on April 16, 1952; H. E. MCCOMB, on October 11, 1952; A. E. MCPHERSON, on August 5, 1952; P. F. NEMÉNYI, on March 1, 1952; and J. L. PETERS on April 19, 1952.

On request, J. H. SERVICE was placed on the retired list.

In view of a provision in the constitution and bylaws adopted by the Washington Junior Academy of Sciences the following was proposed and adopted as the 18th of the Standing Rules of the Board of Managers of the Washington Academy:

18. The President shall designate each year a member of the Committee on the Encouragement of Science Talent to serve as Chairman of the Governing Council of the Washington Junior Academy of Sciences.

Senior Editor FOSHAG reported that the JOURNAL now has a backlog of papers awaiting publi-

cation sufficient to fill six issues. His report was discussed by Messrs. McNISH and RAMBERG, and it was brought out that in so far as possible charges to authors are kept at a minimum and occur primarily when there are a large number of illustrations.

Because of an expressed interest in the JOURNAL as a possible medium for more papers on physics, Dr. F. N. FRENKIEL, of the Johns Hopkins Applied Physics Laboratory, had been invited to present his views at this meeting of the Board. He was asked to present his thoughts. Dr. FRENKIEL stressed the following points:

1. Existing journals do not seem satisfactory for many general articles on physics as these journals individually cover only highly specialized fields. Thought is now being given to the establishment of additional journals.

2. It would not be a difficult matter to enlarge the JOURNAL of the Academy and to publish a good many articles in physics and engineering. These articles in other magazines must be self-supporting.

3. One serious drawback to publication by physicists in the JOURNAL arises from its limited circulation among physicists and libraries.

4. Another arises from the fact that the Academy, because it has no library, does not maintain exchange relations with other journals. Thus the JOURNAL is not well known except in highly specialized fields.

5. Thus, it seems that a field of coverage in scientific applications of physics and engineering exists which, were the academy interested in expanding the size and distribution of its JOURNAL might be more actively exploited.

6. This would entail an interested and well-qualified group of physicists who would contribute regularly and would assure initially several articles in each issue over, say a period of one year.

7. With this backlog as a basis for an announceable change in policy of content an attempt at increased circulation should succeed.

8. Other scientific and mathematical journals ask laboratories and firms to pay for the publication of articles by their staff members. Government laboratories might well give some such backing through assured purchase of reprints which they need.

9. Because Washington has a very large scientific population it should have a satisfactory local publication that would publish articles promptly.

The discussion was continued by Messrs. FOSHAG, MCNISH, MCPHERSON, RAMBERG, and SETZLER. It was pointed out that: A, The Academy must be willing to have its present JOURNAL grow in size and circulation; B, the price of the JOURNAL might have to be increased; C, definite assurance of suitable articles would have to be determined and announced; E, individuals and libraries would have to be circulated and sent free sample copies. President RAMBERG asked the Board of Editors to give this proposal its consideration.

Vice-President MCNISH reported that the Philosophical Society had held its first meeting in the New Auditorium of the Cosmos Club. The acoustics are good and a new projector has been ordered. The Philosophical Society would be willing to contribute toward a good moving picture projector if the other Affiliated Societies will participate. The vice-presidents were requested to ask their societies whether they could make substantial contributions toward such a projector.

President-Elect Setzler mentioned receipt of a request for assistance from the Joint Press Relations Committee that supplies the Science Calendar material regularly to four Washington papers, the Engineers' Club, three universities, and eight technical or governmental bulletin boards or papers. The budget amounts to $125.97 for the coming years. It was understood that the Treasurer will forward half this amount as a contribution of the Academy and its affiliated societies.

The meeting was adjourned at 9:45 p.m.

F. M. DEFANDORF, *Secretary.*

Obituaries

PAUL FELIX NEMÉNYI. The formal details of Neményi's life are as follows: Born June 5, 1895, in Fiume; Dipl. Ing. Budapest Inst. Tech. 1918; Dr. Ing. Berlin Inst. Tech. 1922; Habilitation; died March 1, 1952, in Washington, D. C.

Neményi's life-long interest was pure mechanics. He worked mainly in five fields: static elasticity, fluid dynamics, hydrology and hydraulics, organization of mechanics, methods of research.

The first of his three major discoveries in elasticity was a new singularity method [Zeitschr. Angew. Math. Mech. **9:** 488 (1929); **10:** 383 (1930)]. A number of rather complicated singularities, obtained by confluence of simple ones, are classified in terms of their influences in accordance with a duality principle. Neményi's statement of this generalization of Maxwell's reciprocity theorem is: "The influence lines, influence surfaces (or in general the influence fields) of any influence in the elastic solid, can be represented by deflection curves, deflection surfaces (or in general by the displacement field) of the same solid, if acted upon by a singularity *dually corresponding* to the influence in question." Possibly this principle, which has not attracted the

attention it deserves and has never been put into mathematical form, could be made the basis of a general integration procedure. Neményi was content to illustrate its usefulness in special problems concerning beams, plates, and slabs.

His interest in analogies, which he collected and always planned to organize into a treatise on the method, may well have begun with his own discovery that the stream-lines of any potential flow of an incompressible fluid may serve also as stress trajectories for a plane elastic system. He first approached the problem through his method of singularities [Proc. Int. Congr. Applied Mech. 1930]; later [Zeitschr. Angew. Math. Mech. **12:** 364 (1931)], he gave an analytic proof of this beautiful result in the reformulation now called "Neményi's Theorem": *Given any net of isothermal curves, there exists a five parameter family of plane stress systems for which these curves are stress trajectories.* Phrased thus in terms of pure elasticity, it suggests another question: To what extent is the solution of a problem in continuum mechanics characterized by an associated trajectory system? This subject attracted Neményi throughout the rest of his life. For a certain class of problems in plane plasticity, it was answered in a paper written with Van Tuyl [Quart. Journ. Math. Mech. **5:** 1 (1952)]; a more general elastic case is considered in a paper written with Sáenz [Journ. Rat. Mech. Anal. **1,** 73 (1952)]; and related problems were solved by Prim and Sáenz.

His third major discovery in elasticity is the reduction of the general extensional theory of thin shells of revolution with meridian $y = f(x)$ to the remarkably simple equation

$$\frac{U_n''}{U_n} + (n^2 - 1)\frac{f''}{f} = 0.$$

The functions U_n, called "Neményi's stress functions," yield at once the nth Fourier coefficients of all stress resultants. This fact has been made the basis of an analytic theory for this class of shell problems, and to the equation itself, which should be called "Neményi's equation," some subsequent literature has been devoted. Neményi discovered the result by an intricate analysis in graphical statics [Bygningsstatiske Meddelelser (1936), abstr. in Proc. 6th Int. Congr. Math. (1936)]; later an analytical derivation was obtained [Proc. Nat. Acad. Sci. **29:** 159–162 (1943)].

All this theoretical work illustrates the inverse or semi-inverse approach, of which Neményi was a strong advocate. He summarized the field in a fine organizational summary [Adv. Applied Mech. **2,** 123–151 (1951)]. While this paper does not contain any original contribution, the viewpoint expressed is sound, and the special cases presented are strong advocates for the value of the method. The paper itself is significant as a counter to the current flood of blinding calculation of "approximate" solutions; it deserves careful reading and reflection from every serious student of mechanics. In papers written jointly with Prim [Proc. Nat. Acad. Sci. **34:** 119 (1948); Journ. Math. Phys. **27:** 130 (1948); Proc. 7th Int. Congr. Appl. Mech. **2:** 300; Quart. Journ. Math. Mech. **2:** 129 (1949)] he applied inverse and semi-inverse methods to obtain numerous exact solutions of the nonlinear equations of gas dynamics, many of them representing rotational flows of nonuniform total energy. He named and pointed out the importance of "generalized Beltrami flows," in which the reduced velocity is a Beltrami field, and obtained many examples. The impressive variety of results to which his viewpoint, complemented by proper analytical apparatus, has ultimately led may be seen in the Princeton thesis of Prim [Journ. Rat. Mech. Anal. **1:** 425–497 (1952)].

Neményi's scientific knowledge extended well beyond the subjects of his researches, and the organization and scope of his numerous expository articles give them permanent value; e.g., "Selbstspannungen elastischer Gebilde" [Zeitschr. Ang. Math. Mech. **11:** 59 (1931)], "Tragwerke auf elastisch nachgiebiger Unterlage" [ibid.; 450]. He was a leading authority on fishways [Iowa Studies in Eng., Nos. 23 and 24 (1941)] and the morphology of rivers [forthcoming review in Trans. Amer. Geogr. Union]. His "Wasserbauliche Strömungslehre" [Leipzig, 1933] was the first book to include an exposition of fluid flow through porous media. Other surveys deal with water power, soil mechanics, theory of structures, transport of granular materials, and filtration. He left a draft for an extraordinary book on fluid mechanics, emphasizing the basic principles valid for all types of fluids and the consequent variety of their application to aerodynamics, hydraulics, meteorology, oceanography, and other fields. The introductory chapter is an analysis of the historical development of the main ideas and concepts, both in theory and in experiment, drawn entirely from the original sources. It will be completed and published as a memoir.

Experimental work always interested him, and by inserting into a stream a lens-shaped rotatable tube, punctured by a single hole and connected to a manometer, he was able to make rapid measurements of velocity direction along with speed and pressure [*A new device for direct stream field studies*, Copenhagen, 1935].

Neményi's interest and ability extended to several nonscientific fields. He collected children's art and sometimes lectured upon it. One of his last works is a brilliant review of the Encyclopedia Brittanica [New Republic, Feb. 19, 1951].

For any person with a genuine question in mechanics, Neményi was always willing to supplement his great knowledge and deep understanding by hours of library work. Since 1946 many of his ideas were worked out by his pupils: (in temporal order) C. Truesdell, R. C. Prim, A. Van Tuyl, A. W. Sáenz, R. Toupin, J. L. Ericksen.

After a life of travel and change, during which he held minor positions in institutions in several foreign countries, Neményi came to the United States in 1939. Unfortunately here he found the problem of livelihood aggravated by the rifts between pure and applied mathematics, between pure science and engineering, between classical and modern physics, between teaching and research. For a no longer young person, whose English was poor, whose dress was unconventional, whose training was in civil engineering, and who claimed to be a physicist doing research on the principles of continuum mechanics, the mere gaining of daily bread became a major obstacle. With one exception, it was only in college mathematics departments that he was able to find employment at all, and here it came as a blow to him that a lifelong student of educational methods and one moreover especially attracted by youth could turn out to be utterly incapable of dealing with undergraduate students, whose sole concern was to get a passing grade at the cost of as little learning as possible. The fact that most of his publications date from before 1933 or after 1946 is thus easily explained, since it was in the latter year that he joined the Naval Ordnance Laboratory, where he became a guiding spirit in the Theoretical Mechanics Subdivision during its brief period of scientific productivity in 1946–1948. In 1949 he became a member of the Academy. In 1949 he transferred to the Naval Research Laboratory, where he later became Head of the Theoretical Mechanics Section, a position he held at his death.

He leaves a son, Peter, student of mathematics at Princeton University.

C. TRUESDELL.

EDWIN F. WENDT was born May 12, 1869, in New Brighton, Pa., a son of Christian and Agnes Scott Wendt. He was a grandson of John Scott, associate judge of Beaver County (Pa.), a great grandson of Frederick Wendt, pioneer glass manufacturer of Pittsburgh, and a great grandson of David Scott, quartermaster of the army of General Anthony Wayne.

He graduated from Geneva College in 1888 and was awarded the degree of doctor of science in 1913. He entered the employ of the Pittsburgh & Lake Erie Railroad in 1888 as a roadman, eventually becoming assistant chief engineer. He later became engineer in charge of construction for the Lake Erie & Eastern Railroad. He was a member of the New York Central Lines engineering committee from 1907 to 1913.

Dr. Wendt was a member of the government commission which inspected the Alaska Railroad in 1917. He was also a member of the Engineering Board of the Interstate Commerce Commission, and chief inspector in charge of the Eastern Division of the Bureau of Valuation of the I.C.C. from 1913 to 1921. He then left government service to enter private consulting practice, and was admitted to practice before the Interstate Commerce Commission in 1929.

In addition to membership in the Washington Academy of Sciences, he was a member of the American Society of Civil Engineers, the American Institute of Consulting Engineers (president 1936–37), Engineers Society of Western Pennsylvania, Washington Society of Engineers (president 1918), American Association for the Advancement of Science, Signal Section of American Association of Railroads, American Economic Association, Historical Society of Western Pennsylvania, and the Railway Club of Pittsburgh. He was also a trustee of Geneva College for ten years.